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The Galvanic Battery in its various Practical Applications as an Igniting Agent.—By Lieut. R. Baird Smith, *Bengal Engineers.*

Introductory Remarks.

The dependence of the action of the Galvanic Battery on chemical principles, the excitation of that action by the employment of chemical agents, and the habit of considering the Battery as an instrument of scientific research rather than of practical utility, have tended, to a certain extent, to excite impressions unfavourable to its extensive applicability in engineering operations. Practical men naturally dread employing any agent of whose nature they are not thoroughly cognizant, and are therefore liable to be prejudiced against the Battery, by finding themselves unable to apprehend the rationale of its effects. To aid in the removal of such an impression, it may be remarked that an acquaintance with the theory of the Battery, is by no means essential to the comprehension of its mechanical details and applications, as a little experience would immediately prove. A few opportunities of observing the Battery in action, of noting the different manipulations, such as forming connections, apportioning solutions, &c. will, with common intelligence, enable any one to employ it independently. The remembrance of what has already been done, both at home and in this country, will also tend to remove any farther prejudice which may exist against the practical application of the Galvanic Battery.

Having long been impressed with a sense of the great economical importance of the Battery in all the varied operations in which the explosive force of gunpowder is employed, and having had an excellent opportunity of becoming acquainted with its details during the progress of the demolition of the barque "Equitable," in which I had the pleasure of being employed under Capt. Fitzgerald, I was led to prepare this paper, in the hope of rendering the experience then attained, available to the fullest extent for the benefit of others under similar circumstances. After a considerable portion of it had been written, I learned that a pamphlet by Col. Pasley on the same subject was in course of publication, and I therefore immediately laid my paper aside. On receiving Col. Pasley's pamphlet, however, I found it was entirely confined to details of his own plans, and as experience had proved that these admitted of most material improvements and modifications, I conceived my paper might still be useful, and accordingly resumed and completed it. The original plan has been extended by the addition of a section "on the Theory of the Battery," in which the recently published views of Sir Michael Faraday on this long disputed point, have been briefly developed; and as his researches have entirely removed it from the domain of "doubtful knowledge," as he himself terms it, to that of inductive certainty, the addition may prove interesting to those who desire to understand the principles as well as the practical applications of the Galvanic Battery.

Section I.—*The Construction of the Galvanic Battery.*

The elementary form of the Galvanic Battery consists simply in the interposition, between two plates of different metals, (usually copper and zinc) of a fluid capable of exerting some action on one of these plates, while it has none, or at least a different one, on the other. A communication established between the plates, either by direct contact, or by the interposition of some conducting substance, then admits of the circulation of a current of Galvanic electricity.

It would be foreign to the design of this paper, to dwell upon the various combinations and modifications of the above elementary Battery, by which different compound circles have been formed; and information concerning these is the less called for, since all have been recently

superseded by an arrangement due to Professor Daniel, in which the removal of the defects of former constructions has been accompanied by some most important and peculiar advantages. Of this alone, therefore, will the details be given, and as zinc is procurable in this country, both in the massive and laminar states, a simple modification of the constant Battery adapted for the use of each, will be described.

In the original form of the constant Battery in which the zinc is [Fig. I. a.] used in solid rods, the copper element consists of a cylinder of that metal in its thinest obtainable state. The cylinder is formed, as shewn in Fig. I, with a small collar, and to one side of it a small copper cup to contain mercury, or a clamp-screw socket for facilitating metallic connections throughout the Battery, is attached.

The zinc element is a rod of that metal, varying in diameter and [Fig. I. b.] length, according to the strength required for the Battery, perforated at one extremity by a thin piece of wood, which, on the zinc being inserted within the cylinder, rests on the collar, and prevents any direct contact of the two metals. The rod is usually amalgamated with mercury, as will subsequently be described, and its exterior end is made to terminate in a small mercurial connecting cup, or clamp-screw.

The principal objection to the earlier forms of the Battery arose from the rapidity with which the energy of their action was found to decline. On this being traced to the deposition of particles of reduced oxide of zinc on the copper plate, in consequence of certain chemical actions within the cell, its recurrence was prevented in the constant [Fig. I. c.] Battery by the interposition of a membranous partition beteen the two metals. This membrane is usually made of ox gullets, and is so constructed, as readily to fit on to the collar of the copper cylinder. Thus, then, the Battery when complete, with the exception of the solutions, consists, (1) of the copper cylinder; (2) of the membrane within this; and (3) of the zinc rod separated from the copper by the membrane. The dimensions vary according to the strength required for the Battery; that employed by Col. Pasley in his experiments in February 1839, consisted of 10 cylinders, 21 inches high, by 3½ ditto in diameter, with zinc rods one inch in diameter.

The modification of the constant Battery necessary for the employment of sheet zinc, consists simply in making the copper cells rectangular instead of cylindrical, and the adoption of this form is much

accelerated by employing pasteboard instead of ox gullet partitions, a suggestion due to Dr. O'Shaughnessy of Calcutta. The details are as follow;—

1. The dimensions having been decided upon, a piece of sheet copper of [Fig. II. a.] the proper size, is to be formed into a rectangular cell, the junctions of the side pieces and bottom being soldered with hard brass solder. As the power of a Battery is considerably augmented by bringing the opposite surfaces of copper as near as possible to each other, the edge and bottom pieces of the cell are usually very small in proportion to its sides. When the latter are 14″ or 15″ square, the former may conveniently be made half an inch in breadth. A small connecting tube, about an inch in depth, or a connecting screw soldered at the top of one of the edge pieces completes the copper element.

2. The partition cases are made of common strong brown pasteboard, [Fig. II. c.] two pieces of this being laid together, and their edges or three sides compressed between strips of teak wood, half an inch in breadth, 1-8th in thickness, the length being regulated by the dimensions of the copper cell into which the case should slide easily. Screw nails of copper, if such are to be obtained, but otherwise of iron, passed through the teak binders and the pasteboards, render the case water-tight at the edges, and complete its manufacture.

The zinc element consists of a piece of the sheet zinc of commerce [Fig. II. b.] (spelter) of such a size, as to admit of its readily passing inside the pasteboard case, and rounded off, as shown in the sketch. A thick copper wire is soldered to it, to facilitate the connections throughout the Battery, by dipping into the mercurial cups above described.

A Battery of this rectangular form was used in the destruction of the barque "Equitable," having side pieces $14'' \times 14''$, edge and bottom ditto $14'' \times 1''$, pasteboard cases $13\frac{1}{2}'' \times 13\frac{1}{2}''$, and zinc plates $12'' \times 12''$, the number of cells employed being 12.

Section II.—*Of the Exciting Solutions for the Battery—their nature, preparation, and proportions.*

It has been found by experience that strong chemical action on the zinc of a Battery, with the interposition of a good conducting solution between the zinc and the copper, are the conditions by which powerful galvanic action is insured.

With the constant Battery, solutions are always employed in pairs, of which sulphate of copper invariably forms one, and sulphate of soda or dilute sulphuric acid, may be used indiscriminately as the other. A saturated solution of sulphate of copper, or blue stone, is prepared by adding this substance to boiling water till the water ceases to dissolve it, and then allowing the mixture to cool. Should any crystals of the blue stone be deposited during the cooling, it is a satisfactory proof that the solution is fully saturated; if no such deposit takes place it is advisable to add more of the salt to the water. A simple method of ascertaining, during the progress of preparation, whether the solution has reached the point of saturation, is to place a single drop on a piece of glass, and mark if minute crystals, or solid matter, are immediately deposited, if so, the addition of blue stone may be discontinued. The proper strength will readily however be estimated after a little experience from the intensity of the blue colour of the solution. A proportion of one part of blue stone to three parts of water by weight, has been found by experiment to be most effective, and a large copper cooking vessel is perhaps the best utensil for boiling the mixture in. The sulphate of copper is obtained in the bazaar under the name of "Nila tutiya," and at an expense of from five to seven annas per ℔.

The solution of sulphuric acid, or vitriol, hitherto employed in the cylindrical Battery, is made by mixing one part of strong acid with eight parts of water.

The solution of sulphate of soda, or Glauber's salts, which has been used with the blue water in all the experiments to be subsequently detailed, is prepared by dissolving one part of the salts in eight or nine parts of warm water, and allowing the mixture to cool before use. Its native name is "Kari nimuk," and it is obtainable to any extent at the trifling expense of two rupees per maund.

It is unnecessary to notice the numerous other kinds of solutions which have been proposed, as the preceding are at once effective, abundant, and simple, and will amply suffice for every practical purpose.

Section III.—*Of the Arrangements for bringing the Battery into action, and the precautions to be observed thereupon.*

The first step towards bringing the Battery into action after all the preceding details have been completed, is to charge the cells with

the exciting solutions. The membranous bag of the cylindrical Battery is to be filled with the dilute solution of vitriol, so that this may be in contact with the zinc rod, and the space between the membrane and the copper is to be charged with the saturated solution of blue stone.

In using the rectangular Battery, it is necessary to soak the paste-board cases in the dilute solution of sulphate of soda, till they are thoroughly saturated. Each copper cell is then to be made about two-thirds full of the blue stone water, and subsequently the damped paste-boards are to be respectively inserted. The solution of soda is then to be poured inside the cases till the blue water rises to within an inch of the mouths of the cells, care being taken that no extensive inter-mixture of the two liquids takes place. In this case sulphate of soda is in contact with the zinc, and sulphate of copper with the copper elements of the battery.

The cells having thus been charged, the small connecting cups are then to be partially filled with mercury, and to complete the circuit throughout the entire battery, the wire attached to zinc No. 1, is made to dip into the cup of copper No. 2; the wire of zinc No. 2 into the cup of copper No. 3; and thus the zincs of the series are to be each connected with the adjoining coppers. By this arrangement, a copper cup is left vacant at one extremity of the battery, and a zinc wire unemployed at the other. These are usually called the poles, and through them the power of the battery is directed as occasion may demand.

When the zinc plates are new, the solutions well made, and the connections perfect, indications of activity may usually be obtained a few minutes after the battery has been charged. The junction of the two poles by means of a short piece of copper wire having one of its extremities terminated by a small portion of very fine platinum or iron wire, will afford immediate proof of the circulation of the galvanic current, by the heating of the small wire to a degree dependent on the intensity of the action. Should it appear that the ignition is not so decided as might be expected from the size of the battery, it is probable some accidental interruption has occurred within the circuit, and the action of part of the cells been thereby neutralized. To ascertain the locality of this interruption, the test-wire is to be retained in contact with one pole, and the platinum at its extremity made to communicate with each

cell in succession, beginning with the most distant. Passing thus along the battery, the total cessation or marked diminution of the heating power at any one point will indicate the accident to have taken place there, and on examination it will usually be found that either the connecting wires have slipped out of the mercury cups, or that their extremities have become corroded, and unfit for insuring perfect metallic contact, or that the connections have been imperfectly made. The removal of the impediments will be indicated by the full development of the power of the battery, in the intense ignition or fusion of the fine test-wire.

When batteries of a considerable number of cells are employed, it increases materially their igniting power to make the cells act in pairs by connecting two zinc plates directly with two copper cells, so that they may act as one, but with double their former surface.

Reference was formerly made to the propriety of occasionally amalgamating the zinc plates and the extremities of the connecting wires. With the former this is effected by washing the surface of the zinc with a weak solution of sulphuric acid, and then applying a little mercury, which immediately combines with the zinc, and renders its surface bright and smooth. Care must however be taken in handling plates after amalgamation, as they become exceedingly brittle. To amalgamate copper wire, the simplest plan is to brighten the surface, and then to rub the brightened portion with a piece of soft leather to which a little mercury has been made to adhere by means of a thin coat of tallow. After continuing the friction for a short time, adhesion of the mercury to the copper is effected.

The mercury employed in these manipulations generally becomes impure, it may however be purified again sufficiently for use, by straining it through a piece of fine cloth of any kind, by which the dust &c. is removed.

When the object for which the battery was put in action has been accomplished, the zinc plates should be immediately withdrawn from the pasteboard cases, and well washed with pure water till all the black deposit which will be found upon them is removed.

Having recently had an opportunity of perusing Sir Michael Faraday's admirable "Researches in Electricity," I am indebted to that work for the following remarks relative to some farther precautions to

be observed in the use of the Galvanic Battery :—" *Weak and exhausted charges,* should never be used at the same time with *strong and fresh ones* in the different cells of a trough, or the different troughs of a battery ; the fluid in all the cells should be of the same strength, else the plates in the weaker cells, in place of assisting, retard the passage of the electricity generated in, and transmitted across the stronger cells."

" In the same manner, the association of *strong and weak* pairs of plates should be carefully avoided." " The *reversal,* by accident or otherwise, of the plates in a Battery has an exceedingly injurious effect. It is not merely the counteraction of the current which the reversed plates can produce, but their effect also in retarding, even as indifferent plates, and requiring decomposition on their surface in *accordance* with the course of the current, before the latter can pass, is very deleterious. I find in a series of four pairs of plates of zinc and platina in dilute sulphuric acid, if one pair be reversed, it very nearly neutralizes the power of the whole." Another very serious impediment to the full action of the battery, is the deposition of copper on the surface of the zinc. This generally arises from the extensive intermixture of the solutions in consequence of imperfections in the partitions. Great attention ought therefore to be paid to keeping these water-tight at their edges, so that intermixture may only take place through the pores of the substance composing them. In my own experience, I have occasionally found the entire igniting power of a large twelve cell battery lost, from the preceding cause, and I find Faraday repeatedly cautions us against it.

Section IV.—*Of Conductors—their nature, uses, and modes of construction.*

When the Galvanic Battery is required to produce its igniting effects at a distance, as is the case in all mining operations, a path must be provided along which the generated current can find a ready and uninterrupted passage. Such a path is best furnished by metallic wires, the conducting power of the metals being very much superior to that of any other class of substances. Of the metals, copper is invariably preferred, in consequence of its high conducting power, its

ductility, flexibility, and cheapness. The dimensions and other details connected with the conductors are determined by the nature of the circumstances under which they are to be employed, which may be classed under three heads :—

I. When the conductors are simply led along the surface of the ground, as in blasting rocks in quarries.

II. When the conductors are led under the surface of the ground, as in military mining.

III. When the conductors are immersed in water, as in sub-aqueous mining operations, for the removal of sunken vessels, or rocks in the beds of navigable rivers, &c.

In the first case, the conductors require no protection whatever, and may be formed of naked wires, care being however taken that while the operations are in progress, no metallic contact takes place between them. This might be effectually guarded against by inserting corks or pieces of wood between the two wires, at convenient intervals, throughout their length.

Our information relative to the best arrangements for conductors employed in military mining operations is still very limited, a few experiments due to Colonel Pasley being all that has yet been published on this branch of the subject. It is only at establishments where military works are continually being executed, that facilities for experiments of this kind can be obtained, and it might be worth while on the part of Government to sanction a series of them, at the head-quarters of the Sappers and Miners at Delhi, where, during the practice season, all the requisite facilities would be readily available. Colonel Pasley employed the same conductors in his military mining experiments as in his sub-aqueous explosions; they were elaborately insulated by repeated applications of water-proof composition, tape, and spun yarn, as will be more fully described hereafter. Although I feel considerable hesitation in venturing to express an opinion on a strictly experimental point, I am yet inclined to believe that, especially in dry earth, the minimum of insulation will suffice; a single covering of tarred tape to each wire, would, I believe, prove effectual under such circumstances.

In the third and last case, when conductors are immersed in water, the arrangements for insuring their efficiency are necessarily more

intricate. Water, especially when holding saline matters in solution, being a good conductor, its contact with the wires during the passage of a galvanic current would tend much to diminish the igniting power of this; to prevent such an effect is therefore of primary importance in the formation of conductors for sub-aqueous operations. Colonel Pasley, to whose zeal practical science is so much indebted, has described a very effectual method for insuring the insulation of conducting [Fig. III. a.] wires. In his plan "A $1\frac{1}{2}$ inch new tarred rope of the intended length of the conducting wires is passed slowly through boiling Stockholm tar, which renders it impervious to water,—a necessary process, or the rope on becoming wet after the wires are attached to it, as described below, would shrink one foot in 100 feet, and draw the wires into kinks." Two copper wires *b.* each 20 feet longer than the rope, after being annealed, are separately coated with water-proof composition (made by melting 1 ℔. of pitch, 2 oz. of bees' wax, and 2 oz. of tallow together, taking care that it never boils) and are covered with cotton tape, which is bound round the wire while the composition is hot. The wires are then bound to the rope by strong packthread, *c.* a turn being taken round each wire every time to prevent the *d.* possibility of their shifting. This being done, they are to be bound round again with coarse tape $1\frac{1}{4}$ inch wide, after another *e.* coating of composition has been laid on. Lastly, the whole must be served with new tarred yarn, and again paid over with the composition, when the process is complete. These arrangements, there can be no doubt, would be most effective in preventing any water from reaching the wires, but the resulting conductor is objectionable on account of its very great weight, and the difficulty of managing it when its length is considerable, especially in situations where strong tides and currents [Fig. V.] are to be contended against. In a modification of this plan, adopted in some experiments in Fort William, to be subsequently detailed, the preceding objections were, to a considerable extent, *a.* removed. The rope and coatings with tape were entirely dispensed with, the wires were each served with tarred rope yarn, over *b.* which a coat of dammer and grease was laid, the two wires were then lashed together by rope yarn, another coat of composition applied, and the conductor was complete. Five hundred feet of conductor, or one thousand feet of wire were thus prepared, immersed in salt water,

subjected to great strains, and were found most effective. The only objection to the plan arose from the tendency of the thick wire to break, and difficulty of reaching the fracture in consequence of the strong adhesion of the insulating material to the wire. This of course admits of being readily obviated by annealing the wire, or employing a rope of small wires, instead of one thick one.

Another method for making conductors for sub-aqueous explosions [Fig. IV.] characterised by great simplicity, and possessing several important advantages, has been suggested by Dr. O'Shaughnessy. In this *a.* only one wire is insulated, by passing it through a series of corks, which are subsequently coated with water-proof composition, and wrapped round with wax cloth, or some other impervious substance. *b.* The second wire remains unprotected, and is simply tied with twine to the corks. The chief objection to which, in practice, this plan has been found subject, has arisen from the breaking of the corks across, and the consequent exposure of the insulated wire to metallic contact *c.* with the other, or with adjoining substances. This objection might be removed by serving the corks round with yarn, which, without destroying the buoyancy they possess, would effectually remove the danger of accidental contact, or by covering the wire with tape and water-proof composition, prior to its being passed through the corks. In all cases, however, in which charges are employed at great depths, more perfect insulation than this plan affords would, it is conceived, be essential. Under pressure, the corks become saturated with water, and the consequence is that there is then no actual insulation of the wire. To form a perfect conductor, the plan for entire insulation ought therefore to be adapted for that portion of the wires passing vertically downwards, and the corks should be used for the horizontal portion; lightness and buoyancy will thus be combined with complete insulation of that part where insulation is essential, and all risk of failure from accidental metallic contact, or diminution of the heating power of the battery, avoided.

The length of conductors is regulated by the limits of danger from the effects of the explosions, beyond which it is essential to the security of those engaged in the operations, that they should extend. This limit will necessarily vary under varying circumstances, and cannot always be determined with perfect accuracy. In blasting rocks and

military mining, where the charges are carefully calculated to produce certain definite effects, the limit of danger may generally be known, or at least easily determined, but where large sur-charges are employed, experience is still required to shew accurately the extent to which their effects will reach. On this point Capt. Fitzgerald, in his report on the operations for destroying the "Equitable," remarks, "the limit of actual danger with a charge of 2050 lbs. of powder, in a depth of thirty feet of water, may from such experience as this single instance affords, be calculated as something beyond 120 feet. At 200 feet it is conceived that a person in a substantial boat would be perfectly safe, alike from the effects of the waves and the fragments of the wreck;" but should the charge be fired directly from a boat, he recommends "that for charges of the above description, the main conductors should not be less than 250 feet in length." These remarks must of course be received with the caution required by the limited experience on which they are founded, but they will furnish some standard to which, under similar circumstances, reference can be made. The depth of water most materially influences the limit of danger, which rapidly diminishes as that increases. In Colonel Pasley's operations at Spithead, when the depth was about ninety feet, the limit of danger appears to have been scarcely beyond fifty or sixty feet, although the charges ranged between 2000 and 2500 lbs., and instead of a lofty column of water being thrown up, the elevation of the surface over the charge appears to have been but slight, and the visible disturbance comparatively trifling.

In long conductors, it is impossible to have the wires continuous throughout, and the proper formation of the junctions is of essential consequence to their efficiency. The ends of the wires to be connected should either be strongly brazed together, or if this may be impracticable, they should be twisted together in the smallest possible twists for a length of at least six inches. A few turns, or imperfect contact, should never be considered sufficient, as such connections diminish the igniting power of a battery most seriously, while, on the other hand, well made junctions do not perceptibly affect it. To prove this, a thin wire, 1-20th of an inch in diameter, and 100 feet in length, was taken, and the minimum number of cells required to ignite dry saltpetre cloth ascertained. When the experiments commenced, five junctions existed in the conductor itself, while there were two more at the poles of the

battery, and other two at the extremities to which the platinum igniting wire was attached. With these nine junctions, five cells of a battery 14 by $\frac{1}{2}$ caused saltpetre cloth to ignite, but four cells were not able to effect this. New junctions were made at the termination of each experiment, till from nine they extended to *twenty-four*, and still the same strength of battery sufficed to insure the ignition. The junctions were carefully made, and the contact rendered as perfect as possible.

When the distance from which a charge is to be fired is increased, either the strength of the battery, or the diameter of the wires employed, must be increased also. The exact proportion existing between these increments has not yet been decided, and the results of experience, as far as it has extended, must on this point guide our proceedings. Colonel Pasley states that with a battery of 10 cylinders, 21 inches high and $3\frac{1}{2}$ inches in diameter, having zinc rods 21 inches long and one inch in diameter, he invariably succeeded in igniting charges at 500 feet distance with copper wires 1-5th of an inch in diameter. The following experiments were made in Fort William with a battery of the rectangular form, consisting of 12 cells, each 14 inches square on the sides, having edge and bottom pieces 14″ by $\frac{1}{2}$.″ The zinc plates were new and unamalgamated, the pasteboard cases in good order. The solution of sulphate of copper in the proportion of 1 of salt to 3 of water, the sulphate of soda 1 salt to 8 water. The quantity of the former in each cell was $2\frac{1}{2}$ ℔s. by measure, of the latter $\frac{3}{4}$ ℔., and the battery was found to be in excellent action a few minutes after the solutions were poured in. The igniting effe : was ascertained by bringing a small piece of platinum wire, forming part of the circuit, in contact first with dry cloth saturated with saltpetre, and afterwards with fine dry Dartford powder.

Experiment 1. The length of the circuit in this experiment was 300 feet, each conductor being 105 feet long, and composed of three strands of copper wire, each 1-20th of an inch in thickness, twisted like a rope. With four cells immediate ignition of saltpetre cloth was effected, but with three cells it was not till after some time, that the same effect was produced. With four cells the powder ignited readily, but I found it impossible to effect ignition with only three cells.

Experiment 2. The same conductors reduced to 50 feet.

2 cells produced immediately ignition of the cloth.

1 cell singed the cloth, and made it black, but could not ignite it.

2 cells caused the powder to explode directly.

1 cell caused the powder to smoke, but could not ignite it.

Experiment 3. Conductors of single wires, 1-20th of an inch in diameter and 50 feet in length each, were now employed, and the following results obtained :—

4 cells ignited saltpetre cloth immediately.

3 cells merely singed it.

4 cells ignited powder immediately.

3 cells had no effect whatever.

Experiment 4. The same conductors were employed, but thin brass wire was substituted for platinum.

5 cells caused the ignition of saltpetre cloth.

6 cells ditto of powder.

This experiment involves a question of some importance; viz. the substitution of some other material for platinum, which in this country is most exorbitantly expensive. An interesting series of experiments might be made on this point, by which our resources could not fail to be increased.

With the full power of a 12 cell Battery, I have frequently ignited charges of powder in water, at distances varying from 450 to 500 feet, employing insulated conductors; and by such a Battery was the final destruction of the "Equitable" effected, where the conductors were 150 feet in length, 120 of which were placed horizontally, the remaining 30 vertically in the water.

Before concluding this Section, it may be well to describe some expedients which, under certain circumstances, have been employed for the purpose of diminishing the lengths of conductors. The idea of effecting the completion of the galvanic circuit by means of a self-acting mechanical arrangement, appears to have originated with Mr. Martyn Roberts, who claims to have been one of the first who applied the Battery to useful purposes. With the details of Mr. Roberts' apparatus employed in his blasting experiments in Craig Leith Quarry, I am not sufficiently conversant to be able to describe it, but in blasting, such

an apparatus would seldom, if ever, be necessary. It is in removing obstructions to river navigation, where strong tides and currents are to be contended with, making it essential that the conductors employed should be reduced to their minimum length, that self-acting dischargers may be employed to the greatest advantage. We are indebted to Dr. W. B. O'Shaughnessy for an ingenious plan for such a [Fig. VI.] discharger, of which the following are the details. The discharger consists of two distinct parts, having distinct offices, one being intended for completing the circuit, and effecting the ignition of the powder, the other for breaking the circuit, should any accident delay the explosion, and so rendering it perfectly safe to approach the Battery, and if possible ascertain and remove the cause of failure. These two objects [Fig. VI.] are effected by causing wires to pass, as shewn in diagram No. 6, into four glass tubes partially filled with mercury. Over these, fixed in a small wooden framework, is placed a watch, for the hands of which a thin piece of sheet copper is substituted. This is fixed on the arbor of the hands, and each extremity carries, suspended from a short arm, a copper wire, bent like the letter U. The length of the legs designed for completing the circuit is so regulated, that on the copper hand being set to any specified number of minutes, they will not come in contact with the mercury in the tubes till that time has elapsed. Meanwhile the legs of the other wire have been immersed in the mercury of their tubes, but if the circuit is completed without ignition, then the copper hand continuing to traverse the dial of the watch in four or five minutes more lifts them out, breaks the metallic continuity of the circuit, and thus effectully prevents all risk in approaching the Battery. This form of discharger was successfully employed on the occasion of the first explosion of the "Equitable" in the river Hooghly, but it was then apparent that the utmost delicacy was requisite in making its adjustment. This delicacy and minuteness of detail must always prove serious defects in any form of apparatus employed in practical operations, in which so many risks of derangement are incurred, and in the case of the watch-discharger, the expense is an additional objection. The idea of employing such an apparatus, having however been suggested, there was comparatively little difficulty in designing a form of it which should not be liable to the preceding objections, and one was accordingly contrived, which was successfully employed throughout the remaining operations for destroying the "Equitable." The principle of

this will readily be understood by a reference to Diagram No. 7, by [Fig. VII.] which it will be seen that only two mercurial tubes, with one bent wire, are employed. The wire *c. c.* suspended with its legs dipping a little way into the tubes, is attached by means of a thin metallic chain and hook to a loop of string (saturated either in saltpetre or powder, so as to make it readily combustible) which passes through the composition of a portfire *a.* from which, prior to its being fixed in the wooden stand, part of the paper casing has been removed, as shewn at *h. h.* This portfire burning down, ignites the combustible string, and the bent wire falls by its own weight into the mercury, thus completing the circuit. Should any accident delay the explosion, then another portfire *b.* calculated to burn four or five minutes longer than *a.* discharges a weight *d. d.* attached to it by means of a loop of string, rendered combustible as before. This weight on falling, raises the bent wire to which it is fixed by means of a thin chain, completely out of the tubes, and thus effectually breaks the circuit. On the first occasion on which this portfire stand was employed, it was discovered that the composition of the portfire *a.* just as it burnt out, fell into the tubes and checked the free action of the apparatus, but this was immediately afterwards rectified by the addition of a small copper plate *e.* for the portfire to rest upon, in the centre of which an aperture was pierced, just large enough to admit of the combustible string passing through. Throughout the very extensive series of experiments, which was made to test the action of the apparatus prior to its employment, on the occasion of the final demolition of the "Equitable," no instance occurred in which the composition, even in the smallest quantity, fell into the mercurial tubes, and this result was the more satisfactory, as some considered the above defect fatal to the practical utility of the plan. Its susceptibility of derangement was severely tested on the day of the explosion, as the water was very rough, and the wind high, so that the boat in which the apparatus was fixed, was continually coming in collision with the neighbouring row-boats, and although large quantities of the solutions of the batteries were thrown out in consequence, no part of the portfire stand was in the least degree disturbed, its subsequent action being as complete as could have been wished. The expence of the portfire stand is extremely trifling, as it may be made of any old materials which may be available.

Section V.—*Of the Application of the Galvanic Battery in Blasting Rocks.*

The arrangements necessary for the employment of the Battery in blasting operations, are exceedingly simple. The blast hole having been prepared, and the charge introduced, the igniting wires must be inlaid in a conical piece of wood, and fixed in the grooves prepared for them by a thin wedge of wood, as shewn in Diagram No. 8. The [Fig VIII. a.] igniting wires projecting about an inch beyond the base, or larger end of the cone, must be connected by a fine platinum or iron wire, and round this a cartridge of finer priming powder must be placed. The cone is then to be inserted in the blast hole, and by gently pressing it down and turning it round, the larger end should be made to rest on the charge. A tamping of small fragments of rock must then be poured in over the cone, and the whole arrangements are complete. The main conductors should then be attached to the priming wires, and on the circuit being completed at the Battery explosion will ensue. In the event of the common methods of tamping being employed, it would perhaps be the best plan to continue the use of the priming needle, and have an open communication from the surface through the tamping to the charge. The priming wires, inlaid in opposite sides of a bamboo, could then be introduced, and the igniting wire placed in direct contact with the powder of the charge. Had there been satisfactory grounds for believing sand a good tamping material, the use of the battery would have been much facilitated, as it would only have been necessary to pour the sand into the blast hole after the wires had been properly arranged; but I have in another place detailed some experiments, which, as far as they extend, militate against the employment of this material in blasting, and confirm Colonel Pasley's previously expressed unfavourable opinion of it.*

For blasting rocks under water, a very slight modification of the existing plan will admit of the use of the Battery. The tin case in [Fig. IX. a.] which the charge is to be lodged, must be made with a collar about three inches high, and $1\frac{1}{4}$ inch in diameter. A wooden plug *b*, must be turned to fit closely into this collar, and grooves $\frac{1}{4}$

* Professional Papers of the Madras Engineers, Vol. I.

of an inch deep, cut on its opposite sides. These grooves *c.* are then partially filled, either with common sealing wax or dammer, and the priming wires, previously heated, are made to bury themselves in this. The wax being again softened, a strip of wood is to be forced into each groove over the wire, and every aperture through which the water could force its way, is thus closed. The plug having its inlaid wires connected by the igniting wire, and having a small cartridge attached, must then be driven into the collar of the case, and it only remains to connect the priming wires with the main conductors, lower the charge into the blast hole, and complete the circuit. An arrangement like the preceding was employed in an attempt to fire a charge of powder at the bottom of an artesian well in Fort William, and although the pressure of the water was so great that case after case was burst, yet on no occasion could it be discovered that the water had reached the charge through the plug. A coating of sealing wax, and a tin cap, protected the exterior end of the plug, and prevented the water from passing through the pores of the wood, but this was rendered necessary only by the great depth of water, which was nearly 480 feet.

In some operations, as those for deepening the Pambaum Passage, [Fig. X.] common quart bottles have been used to contain the charges, and when the depth is moderate, I have found, by a great many experiments, that if the priming wires in these are carefully passed through good corks, driven home and coated exteriorly with water-proof composition, the Battery seldom fails to insure their explosion.

Section VI.—*Of the Application of the Galvanic Battery in Operations for removing Sunken Vessels from the Channels of Rivers, &c. &c.*

The great value of the Galvanic Battery as an addition to the resources of the engineer, has in no instance been so fully demonstrated as in operations for removing the wrecks of vessels from the channels of navigable rivers, &c. Every one who has obtained his experience from actual practice in such operations, will be ready to bear testimony to the uncertainty, the danger, and the expense of the arrangements previously necessary for effecting the ignition of the

sub-aqueous charges. The employment of the Galvanic Battery as the igniting agent, removes, to a great extent, these objections, and although, in sub-aqueous operations it is at present next to impossible to foresee and provide against every source of failure, yet the probabilities are now strongly in favour of success, whereas formerly they inclined in the opposite direction. Every successive series of operations will furnish us with new information, and every failure of which the cause is detected, will point out to us new precautions, so that in time we may expect to see the arrangements for employing the battery so fully matured in all their details, as to illuminate entirely those sources of accident, which in the existing state of our practical acquaintance with the subject, are so apt to escape undetected.

An object of primary importance in all sub-aqueous explosions, is to render the cylinder in which the charge is to be placed, perfectly water-tight; for, as Colonel Pasley remarks, "if there be even so much as a *pin hole* to admit the water, it will inevitably reach the powder. The material of which the cylinder must be made, will be determined by the depth of water over it. For any depth less than 50 feet, experience warrants me in stating, that a cylinder of wood, prepared like a common cask, bound with iron hoops, having staves an inch thick, and carefully coated exteriorly with sheet lead, will be found effective. Such a cask or cylinder, five feet nine inches long, three feet eight inches bulge diameter, and three feet three and a half inches end diameter, was on one occasion of failure during the operations against the "Equitable," left at the bottom of the river Hooghly, under a pressure of fifty-one feet of water, for twenty-six hours, and on being raised and immediately opened, it was found that the entire charge of 2050 lbs. of powder it contained, was as dry and serviceable as when it was originally put in, and was in fact the identical powder with which, a fortnight afterwards, the final demolition of the vessel was effected. This may be considered sufficient to shew that within depths of fifty feet, wooden cylinders cased with sheet lead, can with safety be employed. With a depth of ninety feet Colonel Pasley appears to have found it necessary to have recourse to wrought iron cylinders, but the limit at which the employment of wood becomes impracticable, has not yet been ascertained. We must wait the results of other experiments ere any decided opinions can be expressed; but I am inclined to think that

when the depth exceeds sixty-five feet, a wrought iron cylinder will be found necessary.

For the priming apparatus, the following will, I conceive, be found [Fig. XI.] the safest, and most simple plan. The priming wires *a.* must be inlaid in grooves on opposite sides of a circular rod of teak wood, *b.* about 1′ 3″ long, in the manner formerly described (when detailing the experiments in Fort William) with sealing wax and wedges, *c.* An iron tube, formed of a part of an old gun-barrel, about 1′ long, and having an iron flange 4″ square, carefully soldered upon it *d.* at about three inches from one extremity, must be prepared, and into this the teak rod with its inlaid wires must be carefully driven, till one end is flush with the exterior end of the tube, or that nearest to the flange. Over this must then be laid a thick coating *e.* of melted sealing wax, which both prevents the water forcing its way through the pores of the wood, and also keeps the priming wires at their points of issue from metallic contact with each other. The interior extremities of the priming wires, *f.* must then be connected by the igniting platinum wire, which it has always, as far as my experience goes, been found necessary to solder to the copper with gold solder. A small cartridge of fine dry Dartford or mealed powder, must then be placed in immediate contact with the platinum. The apparatus might now be introduced into the cylinder, and by means of the flange and screws, fixed there; but it is of much importance to have the means of insulating the priming from the main charge, so that in the event of water penetrating to the one, it may not communicate with the other, and it is also very desirable to have the means of inserting and withdrawing the priming apparatus with facility, so as to rectify any accidental derangement which may take place, and these two objects are fully effected by the following plan, *g.* due to Capt. Fitzgerald. A metallic protecting case is provided for the priming apparatus, and made a fixture within the cylinder *h.* At its mouth a fine screw, at least an inch in length, is made, and on the iron tube, immediately beneath the flange, there must be cut a corresponding screw. By these means the priming apparatus can be screwed in, or removed at pleasure. In finally fixing it in the cylinder, washers of leather covered with white lead must be placed beneath its flange, and the small fixing screws must be carefully

brought home. Over all a disc of sheet lead, must be soldered, *h.* and the arrangements of the cylinder, with the exception of the loading, are then complete. The latter is to be effected by setting the cylinder on one end, and pouring in the powder through an aperture, about an inch in diameter, in the other. This aperture must afterwards be filled by a wooden plug, and all the stray grains of powder being carefully removed, a piece of sheet lead must be soldered over it.

It is an object of some importance to those conducting sub-aqueous operations, to be enabled at any time to assure themselves that the interior circuit of the wires is complete, without being obliged to withdraw the priming apparatus itself. Col. Pasley recommends that this should be done by introducing a portion of slightly acidulated water into the circuit, and noting whether decomposition occurs; but this is a most dangerous plan, and ought never to be adopted. The decomposition of a single grain of water, according to Faraday's recent researches, requires a current of electricity sufficiently strong to keep a platinum wire 1-104th of an inch in diameter and eight inches* long, at a dull red heat as long as the decomposition is in progress, the *quantity* of electricity maintained undiminished. The platinum wire we employ is considerably thicker than the preceding, but still the risk of premature explosion by Colonel Pasley's plan is very great. The danger is removed by employing a very weak galvanic circle and a galvanometer, but as the latter can seldom be met with in this country in its perfect form, I may be permitted, before concluding this section, to describe a simple substitute for it, employed during the operations against the "Equitable" [Fig. XII.] safely and successfully. A piece of copper wire about 1-12th of an inch in diameter, and fourteen feet long, was coiled on a rectangular wooden frame-work, *a.* 6″ long, 3″ broad, and 1″ deep, care being taken to preserve the metallic coils throughout from mutual contact, *b.* The magnetic needle of a small theodolite was then mounted on the point of a common needle, fixed in a thin wooden stand. On placing this within the frame-work, with the coils passing above and beneath it, and directing a galvanic current excited by the

* The above length is stated merely to give some definite idea of the danger incurred; but Faraday states that if the wire were a hundred or a thousand inches in length, and the cooling circumstances alike, the same effect would be produced as if it were no more than half an inch.

insertion of a circle, composed of a single piece of copper and zinc, each 2″ by 1′, into a glass of very slightly acidulated water, through the wire, the needle was immediately affected. Sometimes it merely trembled violently on its pivot; at other times its deflection was considerable, and it never failed to indicate the passing of a current when the circuit was complete. It is only therefore necessary to make the apparatus to be tested a part of the circuit, and if it does not interrupt the circulation of the current, the same appearances will be observed.

The cylinder is lowered to its position near the wreck to be destroyed by means of rope slings and guys. It is usually slung under the bows of a vessel, having davits or fixed pulleys, through which the suspension ropes are led. At the time appointed for lowering the cylinder, this vessel is moored directly over the wreck, the bows being just over the spot destined for the cylinder, and the lowering is effected by gradually allowing the suspenders to glide over the davits till it is felt that the bottom of the river has been reached. A very simple and ingenious plan for insuring the descent of the cylinder in a horizontal position has been suggested by Capt. Bowman, and consists in marking the two suspending ropes at intervals of a foot or eighteen inches apart. By noting these marks, which are alike at corresponding distances in each suspender, the position of the cylinder can immediately be seen, and if one end is lower than the other, the proper correction can be made.

On connecting the main conductors with the priming wires, the greatest possible care must be taken to ensure perfect contact throughout the junctions. Over each junction a piece of wax cloth or canvas should be wrapped, so as to prevent any contact of the conducting wires at those points, and it is sometimes advisable to lash a rough wooden case over the whole of this part of the apparatus.

Section VII.—*On the Theory of the Galvanic Battery.*

The first step towards the establishment of Galvanism as a branch of physical science, was made by Galvani, Professor of Anatomy at Bologna, in the year 1790. The accidental observation of certain muscular contractions in the limbs of a frog lying in the immediate vicinity

of an active electrical machine, and the subsequent discovery that the same movements were produced by touching the limbs with two pieces of different metals, led him to announce that he had discovered a new kind of electricity resident in the muscles of animals. This announcement caused great excitement among men of science at the time, and Galvani's experiments were repeated, with various modifications, in all parts of Europe, being viewed with much curiosity, and giving rise to numerous speculations. The convulsions in the limbs of the frog only took place, it was observed, while sparks passed from the machine, and this fact therefore proved no more than that the muscles or nerves, or the two together, formed a very sensitive indicator of electrical action. It is on the subsequent remark, that by the contact of dissimilar metals, the same convulsions were produced, the science of Galvanism is founded.

The theory by which Galvani accounted for the phenomena he had discovered, was that the electricity originating in the brains of animals is distributed to every part of their systems, and resides especially in the muscles. The different parts of each muscular fibril he conceived to be in opposite states of electrical excitement, and the contractions to be produced whenever the electric equilibrium was restored. This during life was effected through the medium of the nerves, and after death by the intervention of metallic conductors. To the metals themselves he traced none of the peculiar effects produced, considering them quite passive, and only necessary as furnishing channels of conduction for the animal electricity.

These opinions of Galvani were very decidedly opposed, and foremost among his opponents stood Alex. Volta, Professor of Natural Philosophy at Pavia. By him it was maintained that the electricity was developed entirely by the contact of the two metals, and that the muscular convulsions were merely the effects of the passage of the electricity, thus developed, through the nerves and muscles of the animal. The views of Volta were far clearer and more distinct than those of Galvani, and to him belongs the true credit of having called into being the science, which in compliment to him, has been called Voltaic electricity as well as Galvanism.. The latter is perhaps the more common of the two, and I have therefore retained it in this paper, but it must be remarked, that the term Galvanic Battery

involves an anachronism, since this instrument was invented some time after the promulgation of Galvani's experiments, and no portion whatever of the credit due to its invention can be claimed for him, it being the result of original and independent investigations by his opponent Volta. In explaining the action of the Battery, Volta assumed that during the whole time the two dissimilar metals were in contact, a certain force was in constant operation, tending to effect the transfer of electricity from the one metal to the other. To this he gave the name of *electro-motive force.* Thus when zinc, and copper are in contact the alleged operation of this force is to impel the electricity from the copper to the zinc, so as to maintain the latter in a positive state relative to the former, which is itself in this case negative. If therefore the redundant electricity of the zinc be by any means carried off, and the deficiency of the electricity of the copper be supplied from other sources, the electro-motive force will immediately renew this difference of condition, and thus maintain a continual current of electric power, flowing always in the same direction. The office of the fluid in a Battery, according to Volta's theory, is simply to conduct the electricity from one metal to the other, and its conducting power determines the effective quantity of electricity which actually circulates in the Battery. The force ultimately generated was conceived to be the sum of all the forces acting in each cell separately, since the impulses given by the electro-motive force to the circulating electricity, were all in the same direction, and each added its effect to that of the preceding ones. Hence then the interposition of any substance between the two poles of a Battery subjected it to the influence of this powerful electric current. The chemical action of the fluid on either of the metal plates was considered by Volta as in no way connected with the origin of the electricity developed, and his theory consequently took no cognizance whatever of its existence. It was soon however observed, that in thus neglecting chemical action, Volta had committed an important, indeed a fundamental error, since it was found that the quantity of Galvanic effect was always in proportion to the energy of the chemical action, and that the extent of surface of contact between the metals, had no relation to the quantity of electricity developed. It was farther found, that metals did not invariably stand in the same electrical relation to each other, but that this rela-

tion was determined by the chemical properties of the fluid, with which they were placed in contact. Facts like these were quite irreconcilable with Volta's hypothesis, and pointed clearly to the very important relation which obtained between the chemical action of the fluid on the immersed metals, and the development of the Galvanic energy. Dr. Wollaston, by whom chiefly Volta's theory was shewn to be untenable, conceived that the current of electricity was originally determined by the oxidation of the zinc, that the fluid of the circle served both to oxidise the zinc and to conduct the electricity which was excited, and that the contact between the plates served only to conduct electricity, and thereby complete the circuit. Succeeding philosophers, did not receive Dr. Wollaston's views as thus stated, and Sir Humphry Davy proposed another theory intermediate between that of Volta and the preceding. He adduced many experiments in support of Volta's statement, that the electric equilibrium, is disturbed by the contact of different substances, without any chemical action taking place between them. He acknowledged however with Wollaston, that the chemical changes contribute to the general result, and he maintained that though not the primary movers of the electric current, they are essential to the continued and energetic action of every Voltaic circle. The electric excitement was *begun*, he thought, by metallic contact, and *maintained* by chemical action.

Such was the state of the question, when, in 1834, Sir Michael Faraday undertook the investigation of the source of the electricity in the Voltaic or Galvanic Battery. The contradictory evidence, the equilibrium of opinion, and the variation and combination of theory, which he found to characterise the labours of all preceding writers on this subject, forced him to repeat and examine the facts stated, and use his own judgment upon them in preference to receiving that of others. His previous discoveries of the identity of electricity and chemical affinity, of the power derived from the action of the Battery, with the power to be overcome in any body subjected to its influence, gave him the means of examining the question with advantages not before possessed by any, and of which he has made such admirable use, that doubt can no longer be said to obscure the subject.

Faraday had always coincided in opinion with those who maintained, that *action* of the Battery was *continued* by chemical action, and that

the *supply* constituting the current was almost entirely derived from that source, but whether metallic contact or chemical action *originated* and determined the current, was by no means clear to him. To set this point at rest, was therefore the first step in his investigations, and seeing no reason if metallic contact was not *essential*, why true decomposition by an electric current should not be produced without it, even in a simple circuit composed of two pieces of metal and an interposed fluid, he accordingly instituted some beautiful experiments under this impression, and persevering, ultimately succeeded in obtaining the most satisfactory evidence that *metallic contact was not necessary to the production of the Galvanic current.* This was farther aptly proved by referring to the spark which appears when the wires of a pair of plates in vigorous action are brought in contact with each other. This spark is occasioned by the electricity passing through a thin stratum of air, and its production proves that electro-motion really occurred while the wires were separated, and anterior to any actual contact between them being the result of the action of pure, unmixed chemical forces.

From his experiments, Faraday accordingly felt warranted in concluding that the electricity of the Voltaic pile is not dependant, either in its origin or its continuance, upon the contact of the dissimilar metals with each other; that it is entirely due to chemical action, is proportionate in its *intensity* to the intensity of the affinities concerned in its production, and in its *quantity* to the quantity of matter which has been chemically active during its evolution. Thus when zinc, copper, and dilute sulphuric acid are used, it is the union of the zinc with the oxygen of the water which determines the current, and though the acid is essential to the removal of the oxide so formed, in order that another portion of zinc may act on another portion of water, it does not, by combination with that oxide, produce any sensible portion of the current of electricity which circulates : for the quantity of electricity is dependent on the quantity of zinc oxidised, and in definite proportion to it : its intensity is in proportion to the intensity of the chemical affinity of the zinc for the oxygen under the circumstances, and is scarcely, if at all, affected by the use either of strong or weak acid. But in considering this oxidation or other direct action upon the *metal* itself, as the cause and source of the electric current, it is of the utmost

importance to observe, that the oxygen or other body must be in a state of *combination*, and not only so, but combined in such proportions as will constitute a substance capable of decomposition, since without decomposition the transmission of a current cannot take place. The presence of such a substance is therefore essential to the action of a Voltaic circuit, and so intimate is the connection between its decomposition and power of transmitting a current, that if the one be checked, the other is checked also, and if the one be stopped entirely, the other stops with it. No Voltaic Battery has been constructed in which the chemical action is that only of combination ; *decomposition is always included*, and is, according to Faraday's belief, an essential chemical part.

But as the quantity of electricity set in motion by the decomposition of a certain quantity of anelectrolytes or decomposable substance, is definite in its action, and cannot by any means be increased beyond a fixed limit, it is evident that the action of each cell of a Battery is not to increase the *quantity*, but the *intensity* of the current circulating. A single pair of zinc and platinum plates throws as much electricity into the form of a current by the oxidation of 32·5 grains of zinc, as would be circulated by the same alteration of a thousand times that quantity, or nearly 5lbs. of metal oxidised at the surfaces of the zinc plates of a 1000 pairs, placed in regular Battery order, because at *each* cell, the quantity of electricity is expended in producing the decomposition of its equivalent of the exciting electrolyte, without which decomposition, as was before remarked, the current could not circulate at all. Hence then the action of each cell is to impel forward the quantity of electricity due to the oxidation of the zinc in any one cell, and thereby to exalt that peculiar property of the current, which we designate intensity, without increasing the quantity beyond that due to the zinc oxidised in that one cell. The waste of power in our common Batteries, in which the zinc of commerce is used, is so enormous as to be almost incredible. Faraday asserts that the chemical action of a grain of water upon four grains of zinc can evolve electricity equal in quantity to that of a powerful thunder-storm, and that with zinc and platinum wires one-eighteenth of an inch in diameter, and about half an inch long, dipped in dilute sulphuric acid, so weak as not to be sensibly sour to the tongue, more electricity will be evolved in

one-twentieth of a minute, than any man would willingly allow to pass through his body at once. The loss with ordinary zinc appears to arise from portions of copper, lead, cadmium, and other metals being set free on its surface by the action of the dilute acid, and these being in contact with the zinc, form small, but very active Voltaic circles, which cause great destruction of the zinc, and in the same proportion as they serve to discharge or convey the electricity back to the zinc, do they diminish its power of producing an electric current, which shall extend to a greater distance across the acid, and be discharged only through the copper or platinum plate which is associated with it, for the purpose of forming a Voltaic apparatus.

These evils are remedied entirely by adopting that process of amalgamation of the zinc described in a former section of this paper, by which its surface is brought into one uniform condition, and those differences of character between one spot and another, which are essential to the formation of the minute Voltaic circles, above alluded to, effectually prevented. Hence the full equivalent of electricity is obtained for the zinc oxidised, and a Battery so constructed is only active while the poles, or, as Faraday calls them, the electrodes, are in connection, ceasing to act, or be acted on, the moment this connection is broken. The superiority of the amalgamated zinc is farther due to the state of the solution in contact with it, for as the unprepared zinc acts directly and alone upon the fluid, which the amalgamated does not, the former by the oxide it produces quickly neutralises the acid in contact with its surface, so that the progress of oxidation is retarded, whilst at the surface of the amalgamated zinc, any oxide formed is rapidly removed by the free acid present, and the clean metallic surface is always ready to act with full energy on the water.

When an amalgamated zinc plate is immersed in dilute sulphuric acid, the force of chemical affinity exerted between the metal and the fluid, is not sufficiently powerful to cause sensible action at the surfaces of contact, and occasion the decomposition of water by the oxidation of the metal, but it *is* sufficiently powerful to produce such a condition of the electricity (or the power upon which chemical affinity depends,) as would produce a current, if there were a path open for it. Now the presence of a piece of copper touching both the zinc and the fluid opens such a path, and its direct communication with the zinc is far

more effectual than any connection formed between that metal and it by means of any decomposable bodies or electrolytes, because when they are used, the chemical affinities between them and the zinc produce a contrary and opposing effect to that which is influential in the dilute acid; or if that opposing action be but small, still the affinity of their component parts for each other has to be overcome, for they cannot conduct without suffering decomposition, and this decomposition is found *experimentally* to re-act upon the forces which in the acid tend to produce the current, and in some cases entirely to neutralise them. Where direct contact of the copper and zinc takes place, these obstructing forces are not brought into action, and therefore the production and circulation of the electric current are highly favoured. Hence the cause of the very great importance of *metallic contact* in the Voltaic Battery.

The liquid in the cells of the Battery has the power of retarding the circulation of the electricity generated, and it acts injuriously in greater or less proportion, according to the quantity of it between the zinc and copper plates, or, in other words, according to the distances between their surfaces. Hence then the reason of the great increase of power obtained by approximating the two metals, and Faraday states that not only is this power greater on the instant, but also that the sum of the transferable power in relation to the whole sum of the chemical action at the plates is much increased. *Double coppers* owe their advantages in part to the same cause, but derive their superiority chiefly from the circumstance that they virtually double the acting surface of the zinc, or nearly so, the action on both sides of the metal being converted into transferable force, and the power of the Battery, as to the *quantity* of electricity evolved, highly exalted in consequence.

The cause of the heat excited during the passage of a Voltaic current, remains still enveloped in considerable obscurity, and a more intimate acquaintance with the modes of action of electrical forces will be required, ere the difficulty can be fully removed. Uncertain as we still are of the precise nature of the electric current, the conclusion that the ultimate atoms of matter are in some way endowed or associated with electrical powers, is forced upon us by nearly all the great facts of the science. The researches of Faraday have led him to notice the truly enormous quantity of this electrical power, associated with

these particles, and he has found, on evidence to which it is difficult to refuse our assent, that no less than 800,000 charges of a Leyden Battery consisting of fifteen large jars, charged by thirty turns of a powerful Plate Electrical Machine in excellent order, are required to produce electricity sufficient to decompose one single grain of water into its elementary constituents! That the heat developed by the action of a Battery, is due to the mutual electrical action of the particles of matter thus highly charged, was originally suggested by Berzelius, the celebrated Swedish chemist, and of this idea Faraday, in the seventh series of his researches, speaks with great commendation, but in the succeeding series, he finds reason to modify his praise, and states that the heat or light exhibit but a small portion of the electric power which acts, and "are merely incidental results, incomparably small in relation to the forces concerned, and supplying no information of the way in which the particles are active on each other, or in which their forces are finally arranged.

Such being therefore the state of doubt in which the immediate cause of the development of heat by the Voltaic current is involved, I do not dwell longer upon the point; but I cannot close this section without briefly adverting to the very beautiful and comprehensive theory proposed by Faraday to explain the varied phenomena of conduction and discharge, as well as many others to which, as being unconnected with the subject of this paper, I do not allude.

The division of bodies into conductors and non-conductors, or insulators, is nearly contemporaneous with the origin of the science of electricity itself, and the states of conduction and insulation have in all electrical theories been assumed as essentially different, although no one has ever shewn in what their difference consists. By a series of most beautiful experiments, Faraday has however shewn indisputably that they are only extreme degrees of *one common condition*, and that they consist in an action of the contiguous particles of matter dependent on the forces developed by electrical excitements. The first effect of an excited body on other matter in its vicinity is, according to Faraday's theory, the production among the particles of that matter of a peculiar state of polarization, which constitutes *induction.* If this inductive or polarised state continues undiminished, then perfect *insulation* is the consequence. If, on the contrary, contiguous parti-

cles of the matter, whatever it may, be metallic or non-metallic, have the power to communicate their forces, then *conduction* occurs, and is a distinct act of discharge between these contiguous particles. The lower the state of tension at which this discharge takes place, the higher is the conducting power of the matter. Hence then throughout a wire conveying a charge of electricity, there is a constant series of discharges taking place between the contiguous particles of which it is composed ; and Faraday intimates, in the form of a query, the possibility that these discharges may be similar in kind, though almost infinitely different in degree, to those which take place between two charged bodies through the medium of the air, or other insulating substance. A wire, it has been experimentally proved, has the power of sensibly retarding the passage of a current, and this power of retardation may be traced through a chain of substances till it reaches its maximum in air, but nothing can be detected during this process to shew that its nature has in any way been changed or modified otherwise than in degree, and therefore Faraday asks, "may not the retardation and ignition of a wire be effects exactly correspondent in their nature to the retention of charge and spark in air?"

To enter farther upon the various theoretical questions naturally brought before our view in examining the principles of the Galvanic Battery, would extend this paper to a great, and indeed unnecessary, length, and I trust that what has already been said, will suffice to point out the great principles of its action. The chemical theory of the Battery, and indeed the entire identity of chemical and electrical forces, may now be considered as indisputably established by the researches of Sir Michael Faraday, and the question, as was previously remarked, thereby removed for ever from "the domain of *doubtful knowledge* to that of *inductive certainty.*"

APPENDIX.

Experimental Desiderata.

As many of the details connected with the practical application of the Galvanic Battery still require to be experimentally determined or confirmed, I have thought it might prove useful to append to this paper a few Tabular Forms, shewing to a certain extent the experiments required. Having no higher object than the establishment of rules for guidance in common practice, these forms have not been prepared with a view to great minuteness of quantitative measurement, but they are still, it is conceived, sufficiently extensive to admit of the deduction of valuable practical inferences, and should they not be considered so, they can readily be modified.

In recording experiments, all particulars connected with the Battery employed should be minutely and carefully specified, and it should never be forgotten, that if these are neglected or imperfectly stated, the value of the result obtained is most seriously diminished, and in some cases entirely destroyed. Each series of experiments should be prefaced by a detail of the dimensions of the copper and zinc elements of the Battery; of the state of the zinc rods or plates; of the number of times they may have previously been used; of the state of their surfaces; whether amalgamated or not; of the nature and quantities of the solutions employed; of the nature and state of the partitions of the connections throughout the Battery, and of such other points as the experimenter may consider it useful to note. The same careful detail should be entered into, relative to the conductors used. The results of the experiments should, whenever it is practicable, be entered in their proper columns in the forms immediately on being obtained, as it is impossible to trust to memory for a series of numerical statements, and a single error may cast doubt on a whole set of experiments.

Fig I

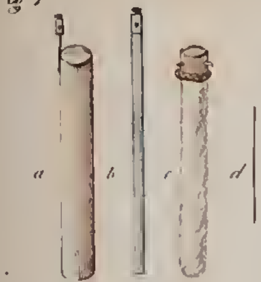


Fig II

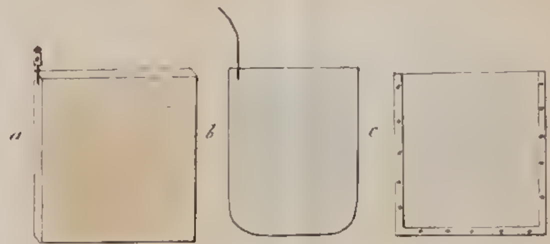


Fig III

Fig IV

Fig V

Fig VI

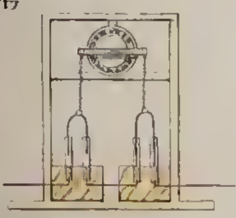


Fig VII

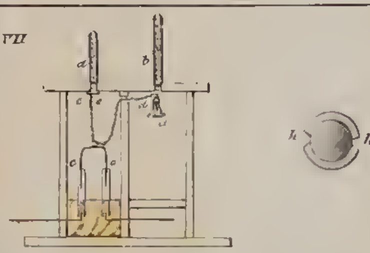


Fig VIII

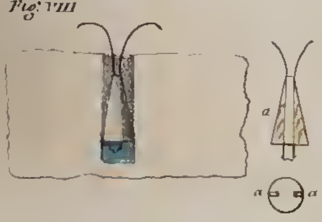


Fig IX

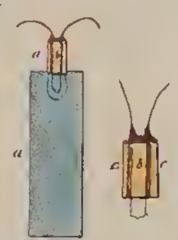


Fig X

Fig XI

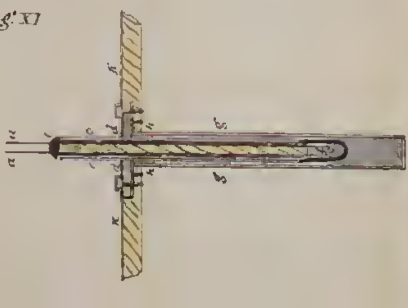
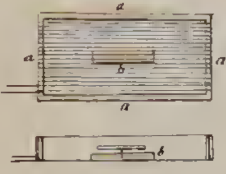


Fig XII



TABLES OF EXPERIMENTS.

To determine the number of cells of a Galvanic Battery (Dimensions, &c., previously specified) required for effecting the Ignition of different substances, at different distances, and with different Igniting Wires.

FIRST SERIES.

Conductors dry and uninsulated.

No. of Experiments.	Length of Conductor.	Diameter of Conductor.	No. of Junctions in Conductors.	Platinum Igniting Wire, 1½ in.			Iron Igniting Wire, 1½ in.			Brass Igniting Wire, 1½ in.			Remarks.
				No. of Cells to Ignite. S. P. C.	Ditto, F. P.	Ditto, C. P.	Ditto, S. P. C.	Ditto, F. P.	Ditto, C. P.	Ditto, S. P. C.	Ditto, F. P.	Ditto, C. P.	
	Ft.	In.											
1	40	1-6th	8	2	2	3	3	4	5	6	7	8	
2	60	0	0	0	0	0	0	0	0	0	0	0	
3	80	0	0	0	0	0	0	0	0	0	0	0	
4	100	0	0	0	0	0	0	0	0	0	0	0	
5	120	0	0	0	0	0	0	0	0	0	0	0	
6	140	0	0	0	0	0	0	0	0	0	0	0	
7	160	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	
24	500	0	0	0	0	0	0	0	0	0	0	0	

* S. P. C., Saltpetre Cloth,
F. P., Fine Powder,
C. P., Coarse Powder,
} Conductors increase in length in arithmetical progression, the common difference being 20.

SECOND SERIES.

Conductors in water and uninsulated.

A. *Water Fresh.*

No. of Experiments.	Length of Conductor.	Diam. of Conductor.	No. of Junctions in Conductor.	Depth of Water.	Platinum Igniting Wire.			Iron Igniting Wire.			Brass Igniting Wire.			Remarks.
					S. P. C.	F. P.	C. P.	S. P. C.	F. P.	C. P.	S. P. C.	F. P.	C. P.	
1	40	1-6th	8	5	3	3	4	4	5	6	6	7	8	
2	60	0	0	0	0	0	0	0	0	0	0	0	0	
3	80	0	0	0	0	0	0	0	0	0	0	0	0	
4	100	0	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	0	
24	500	0	0	0	0	0	0	0	0	0	0	0	0	

B. *Water Salt.*

Form similar to the preceding.

THIRD SERIES.

Conductors in water, but insulated.

A. *By Colonel Pasley's method.*

Form similar to the preceding.

B. *By Lieut. R. B. Smith's modification of ditto.*

Form similar to the preceding.

C. *By Dr. W. B. O'Shaughnessy's method.*

Form similar to the preceding.

FOURTH SERIES.

Conductors under ground and uninsulated,

A. *In Dry Soil.*

No. of Experiments.	Length of Conductor.	Diam. of Conductor.	No. of Junctions in Conductors.	Depth of Soil over Conductor.	Platinum Igniting Wire.			Iron Igniting Wire.			Brass Igniting Wire.			Remarks.
					S. P. C.	F. P.	C. P.	S. P. C.	F. P.	C. P.	S. P. C.	F. P.	C. P.	
1	40	1-6th	8	4	2	2	3	3	3	4	4	5	6	
2	60	0	0	0	0	0	0	0	0	0	0	0	0	
3	80	0	0	0	0	0	0	0	0	0	0	0	0	
4	100	0	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	0	
,,	&c.	0	0	0	0	0	0	0	0	0	0	0	0	
24	500	0	0	0	0	0	0	0	0	0	0	0	0	

B. *In Wet Soil.*

Form similar to the preceding.

C. *In Rocky Soil.*

Form similar to the preceding.—Nature, and if possible, the ingredients of the rock to be specified.

FIFTH SERIES.

Conductors underground, but insulated.

Form similar to the preceding.—Nature and extent of insulation to be detailed.

On the Common Hare of the Gangetic Provinces, and of the Sub-Hemalaya; with a slight notice of a strictly Hemalayan species. By B. H. Hodgson, Esq., *Resident at the Court of Nepal.*

(Lepus macrotus et Oiostolus, nobis.)

It has often been remarked that the ordinary type of the genus Lepus in the Gangetic provinces, differs materially from that of England, and it has been further alleged that the Hare of the Sub-Hemalayan ranges of hills is not similar to that of the plains below them. No one however has, I believe, heretofore been at the pains to verify or refute these allegations, which I therefore now purpose to test, and to show that the former is sound, the latter unsound. I have specimens of the ordinary Hare of the plains and of the hills now before me, and after the most careful comparison, can discern no difference between them in size, proportions, or even in intensity of hue in the colours, further than as such every where varies with age, health, and seasons. The type therefore of this genus in the mountains and in their subjacent plains (on this side the Ganges at least) is the same; and of this species, which we shall call *Macrotus* (from the large size of its ears) the females are, as usual, somewhat larger than the males, being from snout to rump nineteen to twenty inches, with an average weight of 6 lbs. and a maximum of 8½ to 9, whilst the males fall short by one inch or more of this size, and seldom surpass 5 lbs. in weight. The general structure and proportions are those of *Lepus timidus*, but the size is much less, the English hare being ordinarily 8 lbs. and frequently reaching 12 lbs.; and if I may trust my notes, as well as the fresh specimens now on the table before me, the females of *Macrotus* invariably have six teats, of which two are placed on the very top of the thorax, and four remotely from them in a parallelogram in the central part of the abdominal region. This is a noticeable circumstance if the six to ten mammæ of authors be ascribed to the genus with sufficient care, and if *Timidus*, or the European type, may be thence presumed to have ever more than six. If so, the invariably restricted number of mammæ in *Macrotus* will form one feature of specific independency; another will be deduced from its inferior size; and a third from the greater length of the ears as compared with *Timidus*, to which, in its general proportions and colours, it certainly bears a close resemblance; even in colours however, there is at least one material and constant difference, that whereas the dorsal aspect of the scut or tail in *Timidus* is black, in *Macrotus* it is of similar hue with the back, but paler. Nor do I notice in *Macrotus* any peculiarity of structure in the hair (towards tips enlarged, acuminate, and recurved) such as is ascribed to

that of *Timidus.* The general colour of the Indian Hare is a deep cinnamon red, copiously mixed with black on the body superiorly, but unmixed upon the limbs and front of the neck and chest, and also on the nape and dorsal aspect of the neck near it; pure white upon the head and body below, as well upon the insides of the limbs near it, upon the genital region, posterior margin of the buttocks, and whole inferior and lateral surfaces of the tail. The front of the upper lip, the margin of the mouth, a circle round the eye, and a line thence to the nostril are always pale, rufescent, hoary, or purer white, and so also the bases of the ears dorsally, and a strip thence continued towards the shoulders, and bounding the purely ruddy hue of the soft nape. The superior margin of the ears on both sides is black, but the general hue of the fur on the ears anteally is similar to that of the head, whilst posteally and interiorly the ears are nearly nude. The mustachios (which are not undulated) are half black and half white, and though the arms or cubits are usually unmixed with black, yet this is not always the case, the animal in very high fur having the cubits, like the tibiæ (externally) powdered with black. The fur in general is very rich, full, and soft, both the woolly and hairy portions, the former of which seldom exceeds an inch in length, whilst the latter varies from $1\frac{1}{8}$ to $1\frac{1}{2}$ inch. The hair has mostly four rings from the base, thus—bluish hoary, black, red, and black. The wool wants the terminal black ring every where, and is for the most part white, but ruddy apically: the hair wants it on the purely red parts of the animal, such as the abdominal aspect of the neck and the limbs; and both wool and hair are devoid of all rings, and wholly white upon the belly and parts adjacent, as well as upon the inferior surface of the head. Some hairs are wholly black or dusky on the back; but in general besides its bluish hoary base, every hair on that surface of the animal, has two black rings divided by a red one, which latter is of a deep cinnamon hue, almost exactly, or if the reader pleases, brownish-red. The buttocks posteally are less dashed with black than the middle of the back, which in fine furred animals is very dark: but the ordinary dorsal colouring of the hair and wool prevails on the buttocks, as well as on the dorsal aspect of the tail, both parts being like the back, though somewhat paler. Occasionally the wool and base of the hair are dusky, rather than hoary, and the intensity of the red hue, as well as the quantity of black tipt hairs, depend on health, age, and season, both in the hills and the plains. There are of course five digits on the fore extremities, and four on the hind ones, but the thumb consists of a nail only, and the other anterior digits are gradated, as in our hand; whilst in the posterior extremities the central digits are equal, and of the

laterals the interior is the longer. The mustachios are ample, extending much beyond the base of the ears, not harsh, nor adpressed, nor undulated as in *Timidus*, and of many lengths. Above the eye are four to six lesser bristles, and two or three longer ones below it on each cheek. Eyes remote, and much nearer to the ears than to the snout; ears considerably (or $\frac{1}{5}$) longer than the head, so that when pulled forward they may be extended from 1½ to 2 inches beyond the tip of the nose. Head compressed, and arched entirely along the vertical line. Scut without the hair extending only half way from the knee towards the heel of the straightened leg, and with the hair falling considerably short of the os calcis.

The following dimensions will complete the illustration of this species as found in the mountains and plains.

	Plains.		Hills.	
	Mas.		Mas.	Fœm.
Snout to base of scut, ...	1-6		1-6	1-7
Snout to occiput straight, ...	4		4	4 $\frac{1}{8}$
Ditto ditto, by curve, ...	4 ¾		4 ¾ plus	4 ¾
Snout to fore angle of eye, ...	2	less	2 plus	2
Thence to anteal base of ear, ...	1 $\frac{7}{16}$		1 $\frac{7}{16}$	1 ½
Ears length from scull, ...	4 ¾		4 ¾	5
Ditto ditto from anterior inner base, ...	3 $\frac{5}{8}$		3 $\frac{5}{8}$	4 ¼
Width between eyes, ...	1 ¼		1 ¼	1 $\frac{6}{16}$
Scut only, ...	3 ½		3 $\frac{5}{8}$	3 $\frac{5}{8}$
Scut and hair, ...	4 $\frac{7}{8}$		5	5
Olecranon to carpus, ...	3 $\frac{11}{16}$		3 $\frac{10}{16}$	3 $\frac{11}{16}$
Thence to tip, long finger (not nail,) ...	2		2	2 $\frac{1}{16}$
Tibia or knee to os calcis, ...	4 $\frac{14}{16}$		4 $\frac{15}{16}$	5 $\frac{1}{16}$
Thence to tip long toe (not nail,) ...	4 $\frac{1}{16}$		4	4 ¼
Girth behind shoulder, ...	9 ½		9 ¾	10½
Weight (very thin)	4 ½ lbs.		4 ½ lbs.	5 lbs.

The following specific character may perhaps serve to distinguish our animal: *Lepus macrotus*, with black tipt ears longer than the head. General colour, full cinnamoneous red, shaded above with a black: tail dorsally con_ colovous with the buttocks, head below and belly pure white: in size less than *Timidus*. Snout to rump 18 to 20 inches, and weight 5 to 7 lbs. Head (straight) 4. Ears five inches. *Habitatt.* Gangetic plains and sub-Hemalayas. Of the Tibetan species I possess only some wretched remains, which enable me however to indicate the species thus :—

Lepus Oïostolus, with fur consisting almost wholly of wool, considerably curved and interspersed rarely with very soft hairs. Slaty grey blue for the most part and internally, but externally fawn-tinted above, and whitish below and on the limbs: some hairs on the back tipt with black beneath a subrufous ring. Tail white, with a grey blue strip towards the back. Apparent size of the last. *Habitatt,* the snowy region of the Hemalaya, and perhaps also Tibet.

Hares of the first species are exceedingly abundant in the Nipalese Tarai and British districts near it, but less so in the mountains, though there also they may be found in most districts wherein the declivities of the mountains are not very precipitous nor wholly covered with dense forest. Hares love the lower and more level tracts within the mountains, where grassy open spots are interspersed with copsewood under which they may safely rest and breed; for in the mountains the hare never resorts to holes or burrows; nor, I believe, voluntarily in the plains, though I have heard the assertion that it does so. In the plains patches of grass interspersed with cultivation are the favourite resorts of this species, or Jhow shrubberies fringing the banks of nullahs, where, occasionally the animals congregate in numbers wholly unknown to the mountains. The Indian Hare, or *Macrotus,* breeds frequently during the whole year, and produces usually two young ones at a birth. The young are born with the eyes open, and furnished with teeth. In June 1835 I took two from the left horn of the uterus (none in the right) of a female; and these young, though unborn, had the eyes open, and the fur quite perfect. In fact, the young follow their dam as soon as they are born.

CATHMANDOO,
February 1841.

Nepal, March 1st, 1841.

The account of the Hares which I sent you was written *currente calamo,* and without my being at the trouble to look (shame on me) at my own Catalogue of Mammals apud Linnæan Transactions, where the Hare of the plains is named *Indicus,* and that of the Himalaya *Œmodius.* These names might do, and changes are bad: but tropical appellations are objected to, and in the plains there is another Hare, *Nigricollis,* wherefore the names affixed to my paper with you should perhaps stand; but a note at the foot of the page should identify them with *Indicus et Œmodius* respectively of the Catalogue, thus: "These species are named respectively *Indicus* and *Œmodius* in my published Catalogue. Nor perhaps was it worth while to drop the local appellations, though *Nigricollis* constitute a second species in the plains of India."

B. HODGSON.

A short account of Khyrpoor and the Fortress of Bukur, in North Sind. By Captain G. E. Westmacott, 37*th Regt. Bengal N. I.*

[Concluded from page 1113.]

The Indus generally begins to rise in March and abate in the early part of October, but varies in different seasons. In 1839 it just rose in the end of March, but did not overflow until May. It commenced decreasing on the 21st of August, and had fallen twelve feet at Bukur in the end of September, and about four more the close of the month following. The suddenness with which it rises and falls are only equalled by the snow torrents of the Himalayas and Switzerland. I have known the river increase several feet in a few hours, and people are frequently carried away while bathing by a rush of water, which bears them along without the power to resist it. On these occasions boats are driven against the banks, and if old and crazy, break in pieces, and the passengers are drowned.

The shores of the river are fertilized by the annual inundations, and artificial channels are cut from it in the interior of the country to prepare the land for tillage. Some of these useful and munificent works belong to the time of the Mogul emperors of Delhi. A great navigable canal called the "Sind" leaves the river about thirty miles above Bukur, and after passing Shikarpoor pursues a southerly direction to Noushuhra, the boundary of the Purgunnah of Moghulee, and enters that of Chandkoh. Lower down it joins the Nara, which tumbles into lake Munchar after a circuitous course of about 120 miles. Another great canal was cut on the east bank by the late Meer Sohrab. It receives its water from the Indus, a few miles below Bukur, and terminates in the desert soon after passing the city of Khyrpoor. In the height of the floods, however, it flows southwards in a continuous stream, diffusing plenty over a wide extent of country, which would be, without it, an unprofitable waste, and a portion of its waters find their way back through different channels to the Indus. The supplies of this canal have failed within the last two years, and unless pains are taken to deepen it, will soon cease to flow. It would be a serious loss to the people of the capital, who depend on it for wholesome water several months of the year, that which they draw from wells being soft and brackish, and hardly drinkable by persons unused to it. The filling up the canal would occasion a diminution of the revenues, which will probably induce Meer Roostum to repair it. Both the Shikarpoor and Khyrpoor canals frequently overflow their banks during the freshes of the Indus, and dry up when the river subsides. The small cuts that irrigate

the country are exclusively at the charge of the farmer, who contributes likewise to the expense of making and repairing the large canals within his property.

As soon as the waters of inundation evaporate, the soil is ready to receive all kinds of seed almost without preparation. It is sown in the month of October, and always yields an abundant harvest. The river does not occupy above a fourth of its channel in the dry months, and not more than a tenth of the soil on its banks, capable of cultivation, is turned to account. There are vast tracts in north Khyrpoor, which the inhabitants of Bengal would seize with avidity, overrun with tamarisk, and the long feathering grass known in India by the name of Moonj.

The tamarisk springs from the soil within a month after it is deserted by the water, and villagers at a distance from the stream drive their buffaloes to graze on the shoots and young grass which cover the banks. The herbage is extremely nutritious, and communicates great sweetness to the milk of cattle that feed on it. Cow's milk is inferior to buffaloe's milk in richness and flavour. The people convert the milk to ghee, and dispose of it to merchants and boatmen, who carry it for sale to the markets of Roree and Sukhur. The peasants remain at the river in tamarisk sheds until the floods oblige them to retire. Some of the sheds cover an area of several hundred yards, and contain 400 and 500 buffaloes, with the herdsmen, their wives and children. Half a dozen families ofteu crowd into a narrow space divided from the herd by a railing, and cook, eat, and sleep on the ground among milk pots, platters, spinning wheels, and a few articles of common furniture.

There are no rocks in the river above Bukur, and the extent of cultivation on the Khyrpoor side much exceeds that on the shore opposite; the bank is cut to receive Persian wheels, and the peasant removes them when the floods cease to another locality.

The stream of the Indus is foul and turbid, and though little encumbered in the dry months with reeds and drift wood, is sufficiently rapid to hold in solution quantities of sand and other matter it washes along in its course. The number of shoals that perpetually shift their position obstruct the navigation, and render it necessary in the dry season to stop boats while one of the crew is sent forward to sound the channel. Vessels are constantly obliged to cross from one bank to the other, and the want of paths through the dense jungle makes it difficult to carry the track line, and serves materially to lengthen a voyage.

The east part of Khyrpoor is nearly desert, and the scauty supply of well-water loathsome to the taste. The few spots which yield good pasture depend on the rains, which often fail. The supply in 1839 was said to exceed

what had fallen for years, but lasted only four days. In the two preceding years a drought destroyed thousands of cattle.

The *lye*, or tamarisk, is the most abundant production of the wilds, and almost as useful to the Sindee as the bamboo to the native of India. The flowers (*sakoor*) are dried, pulverized, and infused in water, and form a red fluid in which cottons are steeped to prepare them for dye. A considerable quantity of flowers are exported to Persia and the Punjab. The wood supplies the inhabitants almost exclusively with fuel, and they employ it in the construction of houses, boats, and agricultural implements. The boughs are used for fences and cattle sheds, to line wells, and to thatch houses, and are plaited into baskets, and mats for boats, for which their strength and toughness admirably fit them. The young shoots form a nutritious diet for goats and cattle.

Next to the tamarisk in point of usefulness is the *Moonj*, a species of grass which rises twenty or thirty feet high. The peel is twisted into rope for masts and track lines, the texture depending a good deal on the length of time the grass is beaten. The ropes last a twelve month if kept constantly wet, but hot and dry weather destroys them in a third of the time. The string made from the plant is used to lace the common country bedsteads, and the thick part of the stem for screens *(shutees)* for the ceiling and walls of houses. The upper stem bears a long feathering flower, and is made into screens and baskets to hold grain and chaff for cattle.

The *Kas* is another description of wild grass, sometimes used to thatch huts, and cattle browse on the shoots. The *Pees* reed grows on the hills, and is much used for rope, and more pliable than *Moonj*, but wet destroys it; and there is a long flag called *putar* found on the banks of streams and lakes, made into soft pliable ropes, which boatmen pass round their loins in tracking.

Nitre is found in great abundance effloresced on the surface of the soil, and the people manufacture salt more than enough to supply their wants. Coarse salt sells in Roree at four and five muns the rupee, and a fine kind at ten seers.

Coarse cotton cloth *(Khasa)* is manufactured in the principal towns and villages, chiefly for home consumption, and a little is exported to Afghanistan and Persia. Common *loongees* are fabricated at the villages of Raneepoor, Gumbut, Khoora, and Duraz, situated together to the south of the capital. They are chiefly cotton with silk borders, and a few of silk and cotton mixed, and very inferior to the fabrics of Thalfa and Buhawulpoor. Silk cloths are woven at Roree, Khyrpoor, and Shikarpoor, but the weavers are ignorant how to flower and variegate them. Sind caps are

chiefly made at Shikarpoor and Roree, and a common one with a cotton top and silk sides costs a rupee. Common shoes of brown leather are made every where at from four to sixteen anas a pair. They are inferior to those of Buhawalpoor, and the people are unacquainted with the art of embroidering them. Manufactories of paper and gunpowder are established in all the large towns. The best paper factories are at Shikarpoor and Larkhanu, but produce paper of inferior quality to that of Kashmeer and Delhi.

Dromedaries and asses constitute the principal means of conveyance. The duty on grain is often levied on the load, and merchants to save money overload their cattle, and put 800 lbs. on a camel and 250 on an ass. A fine camel will carry this weight easily, but six hundred weight is an average burthen on a long journey, and a female carries one hundred pounds less. The latter is only employed in case of necessity. The best saddle camels come from Kuchee and Jussulmeer, and sell in Khyrpoor at from 100 to 150 rupees, and baggage camels at from 30 to 60 rupees. These were the prices before the British approach; they are now almost double. Camels are ridden on a journey by people of rank, and carry their clothes, provisions, and a servant armed with a sword and matchlock. Merchandise is brought overland from India and central Asia exclusively on the camel, as it is the only animal that can endure the heat and fatigue of the desert in the summer months. It finds nourishment in the most inhospitable spots, and performs a stage of twelve and fifteen miles with ease. Caravans travel at night in the hot months, and the camels are left to browse in the day-time, but in winter the day is devoted to the journey, and the night to repose. These animals are not used to carry swivels, as in Rajisthan, but they turn mills and water-wheels. The Sind camel is the species with one hump, or Arabian camel, usually called the dromedary, and the small breed of Khyrpoor is not capable of supporting much fatigue, nor of lifting the load a good camel of western India will carry. Disease, hard work, and poor diet occasion a great mortality among them every summer.* The lower classes have a large number, and cannot afford them grain, and they feed in the wilds on *juwasee*, and other nutritious shrubs. These depend on the rain, and in seasons of drought, such as 1837 and 1838, the animal is reduced to a state of great misery, and numbers perish. Large herds are pastured by a single peasant, whose maintenance is almost the only charge on the proprietor.

Part of the *Thur*, or Indian desert to the south-east of Khyrpoor, belongs to the Ameers of Hydurabad, and is celebrated for a very superior des-

* During the hot months of 1839 the camels of the British Commissariat at Sukhur died at the rate of one per cent. ?

cription of goats and cattle. The ghee is excellent, but the dealers adulterate it with flour before they carry it to the markets.* A Khyrpoor goat gives commonly three-quarters of a seer of milk, and a fine one that yields a seer is worth two rupees. Goats kept for the table sell at from twelve to twenty anas a piece. A male costs one rupee, and when trained to fight, which is a rather favourite pastime, twice and thrice the sum, and a kid from eight to twelve anas. A good breed comes from Gumo, in the district of Khyrpoor, but Boordgah is considered to produce the finest goats, sheep, and cattle, of any place in the prince's territory. Oobaro, in north Khyrpoor, produces ghee in great abundance, and immense herds of buffaloes are grazed on the banks of the Indus in the districts of Boong and Bara.† The females cost from twenty-five to forty rupees,‡ according to the quantity of milk they yield, a calf ten, and the highest price of a male is twenty-five rupees. A ram costs 1½ rupee: a ewe that gives half or three quarters of a seer of milk, the same: ewes reserved for slaughter one rupee, and a lamb from ten to twenty anas.

The best horses and asses come from Afghanistan and Persia. The horse of Sind is small, lean, and of miserable aspect, but hardy, and capable of enduring great fatigue. Mules for burthen and hire are kept chiefly at Khyrpoor by Talpoorees, who are too poor to entertain servants, and usually accompany the animals.

The ass, like his fellow of Arabia and Egypt, is a small active animal, with considerable power of endurance, and so useful that there is hardly a

* In India ghee is adulterated with Muhooa oil, the *shukurkund*, or sweet potatoe, and the ghoiya vegetable, &c.

† The width of the Khyrpoor territory at Bara and Boong is only ten or twelve miles, and extends along the Indus about thirty miles north of Sulzulkot, and terminates between Boong and Rajinpoor. The possessions of the Ameer of Khyrpoor are represented in Arrowsmith's map to include Rojhan, the chief town of the Muzaree Belooch, but do not project north of Keen in Kuchee, which is nearly opposite Boong. The late Rajah Runjeet Sing seized and annexed Miyan Rojhan to his dominions in the middle of 1836, because of an attack by the Khyrpoorees on his frontier post. Arrowsmith's map of central Asia, dedicated to Lieutenant, now Lieut. Colonel Sir A. Burnes, is I believe the most correct chart of the Indus that has been printed, and at that time (1834) Rojhan belonged to Khyrpoor.

The travelling distance from Buhawulpoor, in Daoodpootra, to Feerozpoor is 160 kos, or 225 English miles. The kos in Daoodpootra is about one mile and three furlongs English, and the frontier extends within 56 miles of Feerozpoor. The Indus constantly changes its channel, and a survey of its course this year might give a very inaccurate representation of it the next. In the summer of 1839 upwards of 4000 bighas of land, partly cultivated, situated midway between Ooch and Mittun, were transferred by a caprice of the stream from the Sikh territory to Buhawulpoor on the east bank. The river is gradually deserting Ooch, which is now upwards of three miles from the bank in the dry season.

‡ These were the prices at Roree and Sukhur before the British entered Sind, and may be taken as the average throughout the country.

family of Moosulmans and Hindoos without one. He brings grass and fuel, carries the merchant and his grain, and the poor keep him for hire. He is never fed on grain, and subsists in the wilds the best way he can, but is always in sleek and comfortable condition.

The pig is not found in Sind in a domestic state, but the villages, like those of India, swarm with a breed of half-wild disgusting dog, who subsist almost entirely on offal.

Tigers, wolves, jackals, boars, porcupines, deer, and hares, harbour in the forests; and among the amphibious animals are the alligator, otter, badger, and porpoise. Alligators inhabit the creeks and minor streams that diverge from the Indus, and are held sacred by Hindoos and Moosulmans. Tigers are rare, and kept by Moojawurs attached to the tombs of eminent saints to attract visitors. The hog is the scourge of the farmer, and he is obliged to employ watchmen at night to preserve his fields from their ravages. Wolves carry off poultry, but seldom attack grown-up persons. Badger and otter skins form an article of export to Afghanistan. Snakes, scorpions, and centipedes abound in rocky situations, and the last attain a large size. Flies, mosquitoes, and many varieties of beetle and grasshopper appear when the inundations subside, but are less numerous and troublesome than in the wet season in India. Leeches are plentiful, and extensively used for venesection. Among the birds are a peculiar kind of Myrops or bee-eater; the black partridge, similar to that of Kuch, but differing from the species found in the north provinces of India; the grey partridge. Two kinds of woodpecker found also in the Konkan; the razor-beak, similar to that of Gujerat; several kinds of gull; the pelican; a species of plover, peculiar, I believe, to Sind; and the Kunchee, or Bhooketta of India, a black bird with long feathers in the tail, remarkable for its antipathy to the crow. Though a third less in size than its foe, the Bhooketta attacks it with so much vigour and determination, that it trembles with fear, and endeavours to escape without offering resistance. Geese, ducks, divers, snipe, and other water-fowl are uncommonly plentiful. The first congregate in thousands on the banks of the Indus and the extensive lakes and morasses formed by its overflow, and form part of the food of the lower classes.

The multitude of fish in the Indus, and the lakes and streams that flow from it, also supply the inhabitants with food. The saleswomen dispose of the small fish by weight, and sell the large ones to purchasers in any quantity they require, by guess. The following catalogue of sixteen, includes, I believe, all the species found in the Indus in Upper Sind. I have added the price in the Roree market of the largest and finest of the kind, but it varies of course with the season and drought.

The Khuggur* ranks first in point of flavour and wholesomeness, and is called par excellence, "The fowl of the Indus." It attains the length of ten or twelve inches, and sells for about three pys.

The Dumra† (Rohoo of the Ganges) is considered next to the Khuggur in excellence. It comes into season in September, and is plentiful the following month. It grows to the length of 4½ feet, and sells for twenty pys.

The Pulla, a kind of carp (Roree of the Ganges, and Hilsa of Bengal.)

The Thelee† is a dark coloured fish, of good flavour, twenty-six inches long, and sells for nine pys.

The Shakir† is eighteen inches long, and sells for five pys, but is not a favourite. There are a few always in the market, but October is the best month for them.

The Singara† is well flavoured, and much eaten. The largest measure about twenty-four inches, and sell for six pys.

The Pundun* (Ruya of the Ganges and Jumna) spawns in the month of Sawun. The largest are six and seven feet long, and sell for eighteen pys, but are not prized from being full of small bones.

The Goj* (eel) grows three feet long, but is little eaten, from its resemblance to a snake. It sells for four pys.

The Lahoor,*† Mŏokŏr,* and Putonee* are each about eighteen inches long, and cost three and four pys. The first is much eaten, but the last is disliked from being full of small bones.

The Dumun† (Kutera of the Ganges?) is nine inches long, and costs two pys. It is full of bones.

The Sonee† measures eight inches long, and sells at three pys the seer. Like all bony fish it is eaten sparingly.

The Pullura is three inches long, and sells at the same price.

The Ghar† and Kooree† are each two inches long, and cost four and five pys the seer. They are great favourites.

When the river is in a state of flood the fishermen live in boats, and at other times on the banks in temporary huts built of reeds and tamarisk cut in the forest. They farm tracts of the river, one or two miles long, by the year, and sometimes pay in kind at the rate of a third or a fifth, and at others head money every second month. Two or three men residing under the same roof, pay less than a single individual.

A fisherman of Roree pays every two months, Rs.	3
Two fishermen together, ...	5
Three fishermen together, ...	7

* Always in the market.

† In season in October and November.

The Pulla fish has been sometimes compared to the salmon, from the extreme richness of its flavour, and is excellent either fresh or salted. When full grown it measures about eighteen inches long, and comes into season in Upper Sind in the month of *Sawun*, when the river is full, and is in its prime about six weeks. The people prize it less than others of the finny tribe from its heating quality, which is said to generate itch and another disagreeable disorder in those who eat it constantly, and it is filled with small bones. The poor Sindees, among other dirty practices, broil and eat the entrails. The price of Pulla depends on the drought. In 1838 a full grown one sold in the Roree market for two pys, but the supply failed in the season following, and the demand made for it by the British, raised the price to six pys.

The peculiar manner of fishing for Pulla has been well described by Burnes in his voyage up the Indus. It is a novel spectacle to see the stream in the floods covered with men floating fearlessly on vessels of baked clay. A vessel (*muttee)* will usually contain twenty gallons of water, and is much flattened at the sides. Those half the size have handles through which the fishermen pass a rope to tie to their waists. The fisher covers the opening at the top of the jar with the pit of his stomach and swims into mid-stream, with a net ready for use on his shoulders. The net is woven in large meshes, and fixed at the upper end of a bamboo, twelve or fourteen feet long, with branches at the top like a fork. He plunges the net vertically into the water and remains motionless with his thighs drawn up on the jar until the fish are snared, when he tightens the mouth of the net, disengages the fish, spears them, and drops them into the vessel.

The fisher usually selects a reach of the river for his employment, and after floating the length of his beat, gains the shore to deposit his spoil. He either transfers the jar to his head, or leaves it hanging to his loins, and with the net on his shoulder walks across the point he swam round, and again commits himself to the water. Fallen trees swept along by the current sometimes break the earthen vessel, and endanger the fisherman's life. In situations liable to this accident, he substitutes for the *muttee* a large gourd enclosed in netting, which he binds over the pit of his stomach. It obliges him to swim low in the water, and often his head and shoulders alone are visible.

The fishermen of the Indus have spare figures and swarthy complexions; they wear beards like the other Sindees, and a wrapper of blue or white calico round their heads and loins.

A *muttee*, or earthen jar, costs from 12 to 16 anas.

A net with a handle of bamboo, or bank wood, 12 anas.

A gourd, 1 or 2 pys.

In lakes, and shoal water produced from an overflow of the Indus, large quantities of Pulla are taken in nets, called *jalee,* fabricated and worked by eight fishermen *(Mohone.)*

Another kind of net used by one man is six-sided, five feet in diameter at the opening, and shaped something like an umbrella without a handle: sticks, four feet long, supply the place of whalebone, and the intervals are filled with net, strong enough to hold fish three feet long. The cost of making does not exceed twelve anas.

The military of Khyrpoor may amount to 10,000 or 12,000 men (Moosulmans), and are paid part in cash, and part in grain at harvest. The Ameer grants lands to chiefs and jaegeerdars on condition of their supporting a certain number of troops for the service of the state in war time. They usually belong to the tribe of their chief, and work in his farm and household when not employed by Government. The soldier's stipend is disbursed half-yearly at harvest, but is frequently in arrears. The infantry get from thirty-six to forty-eight rupees per six months from their chiefs, and half a rupee a month extra in war time from Government. The cavalry receive from ten to thirty rupees a month, and are divided into five grades.

A few of approved courage receive 10 Khurwars* of grain, and 400 rupees in cash half-yearly.

The 2nd class about 8 Khurwars of grain, and 200 Rs. half-yearly.
The 3rd class about 6 Khurwars of grain, and 140 Rs. half-yearly.
The 4th class about 4 Khurwars of grain, and 100 Rs. half-yearly.
The 5th class about 2 Khurwars of grain, and 80 Rs. half-yearly.

In actual war the pay of the first class is increased to 2 rupees a day.

2nd class, ... $1\frac{1}{2}$ rupee per diem.
3rd and 4th classes, ... 1 rupee per diem.

Most of the chiefs are Talpoorees, and also receive an increase of pay when employed, according to their rank.

A Moghul officer in the service of Shah Nuwaz Khan, the minister of Meer Ulee Moorad, receives twenty khurwars of grain and two hundred and fifty rupees in cash yearly to furnish four infantry soldiers. The grain is wheat and joowaree, delivered in equal quantities; the first in the Rubbee harvest, and the last in the Khureef, and the officer is at the charge of conveying it to his farm. The soldiers are Moghuls of his own tribe, and only serve in war, at other times they till his lands free of expence. If the officer's services are required in peace he gets his food from the minister, and always a suit of clothes yearly. The Moghul pays his soldiers at the rate of seven rupees a month, calculated at twenty-one

* One khurwar is equal to 15 muns, or 600 seers.

rupees worth of grain and the same amount in cash each harvest, and they furnish their arms, and when travelling mess with their chief.

Before the British troops occupied Sind there was scarcely any market for grain, but the demand for it has increased since 1839 to such an extent that the Ameers will be obliged probably to reduce the allowance to their troops, and place their pay on a new footing.

The soldiers of the Principality are chiefly cavalry, half of whom ride ponies, and the others camels, horses, and mules. Their arms are swords, shields, matchlocks, and knives. The Ameer's secretary inscribes the name of the recruit and that of his tribe in a register, and it is said that the whole military force could be assembled at the capital within eight days.

The soldier is never punished with stripes, and rarely abused. Meer Roostum makes the chiefs responsible for the conduct of their men, and deprives the guilty of part of their jaegeers. They receive their discharge if dissatisfied. The military are proud, and impatient of rebuke; and though faithful to a commander whom they love, are easily induced by ill-treatment to offer their allegiance to another.

There are no forts in Khyrpoor of any importance except Bukur and Dijee, and they are in bad repair, and incapable of resisting European artillery. There are *Kots* at Shergurh, Moobarukpoor, Oodur, Shahgurh on the Jeysulmeer frontier, Subzul on the Daoodpootra frontier, Kandura between Roree and Khyrpoor, and a few other places. They are merely high mud walls built round a square, and pierced for musketry, but without guns.

Dijee-Kot, or Ahmudabad, merits notice from having been the capital of the Soomras, and was destroyed by Ullah-ood-Deen, Emperor of Dilhee, towards the end of the fourteenth century of our era. It has not yet been visited by a European, and I am chiefly indebted for the following account of it to a Moghul officer lately in the service of the governor Ali Morad, youngest brother of Meer Roostum.

Dijee stands on a hill about eight kos south of Khyrpoor, and three hundred yards from the east bank of the river Meerwah, which is fed from the Indus, but contains water only three months in the year. The prince uses it as a depôt for treasure, grain, and military stores, and resides in the walled village below. There are four or five houses in the fort, and a well of brackish water, which supplies the garrison in time of siege. It is surrounded by a stone and brick wall, about thirty feet high and four thick, without a ditch. The only entrance is from the east through four gates connected by walls, and a *ghorchu* is mounted over the inner one, but none of the others are defended by cannon. The following guns of iron and brass are on the rampart:—

1 Eight cubits long.

3 Seven cubits long.

5 Ghorchu (so called from being drawn by horses) of four or five cubits.

8 Ramjungiyo, or Jinjalls, six or seven cubits.

3 Gobare (mortars) 2½ cubits.

Each Ghorchu requires eight horses to draw it. Most of the guns are new, but would do little against a European army, and the miserable condition of the Sind artillery is proverbial.* The small village of Dijee is surrounded by a wall and rampart twenty feet high, and seven thick at the base; it mounts six Ghorchus, but is too much decayed to offer resistance. Two of the eight gates are closed, and the others without shutters. A sheet of water, ten or twelve feet deep, and 150 or 200 yards wide, which has been formed partly by digging earth for the fortifications, encircles the place during the floods of the Indus, and dries up in the cold months. The village contains three wells of good water, and the country is cultivated on all sides except the east, where there are hills. The crops are Joowaree, Bajree, and Indigo. Fuel is brought from a distance of two kos, and consists of tamarisk, *Kundee*, and *Ber*, (wild bullace). Ali Morad is probably entrusted with the command of Dijee because he is the martial genius of the family, and can assemble between 2,000 and 3,000 picked warriors in two days, from villages within a circle of twenty kos of his residence; they are chiefly Belooch, with some Afghans and Sindees, and one-half cavalry and the other half infantry.

The town of Bukur fills an important place in the history of Sind, and I have abridged the following account of it from a work in the possession of a Suyud family at Roree and Sukhur. The dates in native manuscripts are often faulty, and should be received in this instance with caution.

About the middle of the seventh century of the Hijru a Suyud of illustrious family, named Moohummud Mukaee, arrived at Bukur. He was the offspring of Ameer Moohummud Soojan and a daughter of the then king of Persia (a Turk), who presented him on his marriage with the tract of country situated between Mushud and Kandahar. Moohummud Shoojan subsequently made an expedition to the south of his principality as far as the banks of the Indus, and liking the situation determined to revisit it. He directed his attendants to write an account of the spot, and retraced his steps to Mushud, where he died soon after, and was buried in the mau-

* The Sindees have an exaggerated notion of the destructive power of our guns. When the Ameens of Hydurabad threatened in 1838 to oppose the march of our troops, a nobleman of their Court, who had heard strange accounts of our shells and shrapnells, advised them to desist, as it would be rash to attack an enemy whose cannon discharge balls from both ends.

soleum of his grandfather Huzrut Iman Human Sooltan Khoorasan Ubool Husun Ulcc, son of Moosa Ruza. He left a son named Uhmud, and his widow pregnant of another. When the period of mourning was expired she went on a pilgrimage to Mudina, and from thencc to Mukka, where she brought forth Meer Moohummud, surnamed Mukaee, from his birthplace. On her return to Persia she married a relation, and travelled with him and Moohummud Mukaee to Bughdad, where thcy wcre hospitably rcceived by a nobleman named Shuekh Shahab-ood-deen Soohrwurdee. Hc formed a great friendship for Mukaee, and determined to give him his daughter in marriage, but his relatives supposing him a person of obscure birth, opposed it. The young man was indignant at their conduct, and askcd them to accompany him to the burial place of Moohummud, that he might convince them of his holy origin. On reaching Mudina they entered the tomb of the prophet, when Mukaee cxclaimed, "Salutation to thee, O ancestor," and a voice from the sepulchre replied, "Salutation to thee, O son;" which proof of sanctity so affectcd his companions and the townspeople that they fcll at his fcet, and after showing him extraordinary respect begged him to confer a blessing on their city by tarrying some time in it. He declined, on the plea of returning immediately to Bughdad, but determined first to visit Nujub, to give his companions another proof of his holy lineage. On entering the tomb of Ulee he addressed the spirit of the departed as he had done Moohummud, and a voice from the sepulchre confirmed his origin.

Shahab-ood-deen was overwhelmed with shame at what had happened, and after asking and receiving his forgiveness gave him his daughter in wedlock. In due time the lady brought forth a son called Sudr-deen, whose tomb is in the fort of Bukur, she died immediately afterwards, and her father followed A. H. 587.

Among the papers that came into Moohummud Mukaee's possession on his father's death was the account of the Indus, already mentioned, and being curious to see the spot he travelled thither in the year of Hijru* 658. His companions agreed in considering it favourable for a settlement, and having mounted the hills to reconnoitre they discovered two herdsmen grazing cattle. These men undertook to point out the spot that was so much admired by Moohummud Shoojan, and departing at night they arrived at dawn the following day at the foot of a hill, which the horses

* The late Captain Macmurdo of the Bombay army, states that Bukur was founded by the Arabs, and built from the ruins of Atore. He mentions, on the authority of the Tohfut al Girami, that the town did not exist in the time of the Hindoo government, and that it got its name Bukur from Moohummud Mukaee some years after its foundation.

and camels of the caravan, although urged repeatedly forwards, would not pass.* Moohummud Mukaee declared this a proof it was the site chosen by his father, and kneeling down offered thanksgiving, and because a cowherd conducted the caravan, and it arrived at the place at dawn, he called it Bukur, which means in the Arabic tongue "a cow," and "the morning."

At this period the inhabitants of the country were infidels, and when the governor† Alim Khan Urghoon heard of the new worship he proceeded to seize and punish the offender; on appearing however before Moohummud Mukaee he suddenly lost the power of injuring him, and his disposition changed entirely: he entreated to be admitted to the bosom of Islam, and became one of its most devoted followers. He offered to assign lands to Moohummud Muhaee which the latter declined, and wished to purchase a spot where he could build temples to God. Alim Khan accompanied Sudr-deen to Sehwan to choose a site, and Suyud Ali, a friend of his father's, persuaded him to settle there, and gave him his daughter in marriage. He purchased lands in the vicinity, which he called "Rusoolpoor," but had not been long there when Moohummud Mukaee disapproved of his residing so far from Bukur, and recalled him. He then desired him to mount a domestic on a camel, and promised to purchase of Alim Khan and bestow on him as much land as the animal could traverse between dawn and dusk. The man rode through a district on the east bank of the Indus, which became thence forward the property of Sudr-deen, who cultivated and peopled it. The district is two kos from the town of Roree, and retains the name of Alee-wahun it received from Sudr-deen. It contains the villages of Machee and Turee Chanee, and part still belongs to the descendants of Moohummud Mukaee, and they pay no revenue to government.

Mohummud Mukaee died A. H. 691, and the Suyuds raised his son Sudr-deen to the chief dignity. Alim Khan's death followed soon after, and in the year 697 Sudr-deen invited Nusrut Khan, of the Khilchee tribe, the then Sooltan of Mooltan, to take possession of Bukur. The Sooltan on his arrival gave his daughter in marriage to Budr-deen, son of Sudr-deen, and swore on the Koran to assign a third of his dominions to her in dower, but broke his engagement and gave in lieu of it the country of Umeer Wuhun, now called Surjudpoor, in North Khyrpoor, which continued in the possession of Budr-deen's descendants until the Kalhoras deprived them

* This seems to confirm Captain Macmurdo's opinion that Bukur was not originally surrounded by water.

† He must have received this title on his conversion to Islam; his former name is not given.

of it.* The issue of this union was two sons and two daughters, one of whom married her cousin, the son of Tajood-deen, and received half of Umeer Wuhun for a dowry, Sudr-deen married first the daughter of his uncle Uhmud, by whom he had six sons and two daughters, and secondly the daughter of Suyud Ali of Sehwan, who brought him four sons and two daughters. On his death his eldest son Budr-deen succeeded to the *guddee* of the Suyuds. Sometime afterwards his brothers Ullah-ood-deen and Tajood-deen went to hunt in the forest of Ali Wuhun, and applied to the steward of the chase to defray their expenses; this he declined without Budr-deen's order, and his brothers enraged at his refusal slew him. Budr-deen was restrained by his relations and the Ulema from punishing this atrocious act, but their counsel displeased him, and he left Bukur resolving to fix his residence for the future at Mooltan. He was met, however, at Ooch by Hoosen Khan, a powerful Zumeendar of the Langa tribe, who had heard that the chief Suyud of Bukur was approaching, and went forth with his family to greet him, prevailed upon him by offers of service to settle in that city. He married Hoosen Khan's daughter, and his brothers having afterwards expressed regret for their conduct, returned with his wife to Bukur; about this time he betrothed his daughter to Suyud Julal of Bokhara, who lived on the island of Khwaju-ka-than in the Indus above Bukur, which gave great offence to his brothers, with exception of Tajood-deen, to whom Moohummud revealed in a dream his approbation of the match. His brothers continued in the same mind, and Budr-deen withdrew after the wedding with Julal and his wife to Ooch, and never returned to his native city. The descendants of Tajood-deen, son of Sudr-deen by his second wife, and grandson of Moohummud Mukaee, now occupy the first place among the Suyuds of Bukur and Roree. His great-grandson Saood-deen sat on the cushion A. H. 980. The posterity of Moohummud Mukaee are scattered over the country between Lahor and Thutta, and reside chiefly at Lahoor, Ooch, Mooltan, Bukur, Sukhur, Rooree, Shikarpoor, and Pulot.

I did not ascertain the date Bukur was first fortified. Capt. Macmurdo mentions that when the Urghoons made it their capital it stood on an island in the Indus, and Shah Beg built a brick wall round it for its defence. I find in the history of the Suyuds that Shah Hoosen Khan Urghoon held the government towards the middle of the tenth century of the Hijru,

* Nusrut Khan died A. H. 717, and left a brother named Allah-ood-deen, who was at Bukur at the time of his death. This event was followed by a revolution, and many competitors started for the throne, but I am not aware who succeeded to it. The MS. states briefly that the Jam of the Soomra tribe arrived about this time at Bukur, and assumed the government.

and rebuilt the fort ninety* tunab, or 1350 yards in circuit. Nadir Shah is said to have destroyed the works when he invaded Sind in 1747-48, but they differ little at this day from the description given of them in the time of Shah Hoosen. He made the wall fifteen yards high and four thick, and pierced it with four gates. The Koon, SE. facing Roree, is now shut; the Kingree S.; the Khururee N. towards Sukhur also shut; and the Nag to the N. E.; none of the gates have outworks or barbicans, but steps are cut in the rock for the convenience of obtaining water. The fort is an irregular oval, and has sixty-one bastions of different sizes connected by an embattled curtain, and the diameter, measured from the Koon to the Khururee gate, and from the Nag to the Kingree gate, is the same, namely twenty-one tunab, or 315 yards. Hoosen Khan appointed Muhmood Khan, a noble of his court, to command the fort while he travelled between Mooltan and Thutta, and it was at this period (A. H. 928) that the emperor Humayoon was defeated by Sher Shah the Afghan, and fled towards Bukur. When Muhmood Khan heard of his approach he hastily built an Alum Punah, or outer-wall to the fort, which embraced the whole of the limestone rock in the Indus, and was 125 tunab, or 1875 yards circuit, twelve yards high, and four thick, with four gates opposite those on the inner wall. It had seventy bastions, and two gardens called Nuzurgah and Goozrgah, which are now planted with date trees. Muhmood Khan had scarcely completed the defences when Humayoon arrived, and requested admittance. The governor gave no answer, and closed the gates, and reduced the imperial army to great distress for provisions. The Suyuds in Bukur pitying their condition, sent the emperor a present of sixteen hundred Khurwars† of grain, which relieved the wants of his army for a time, but the garrison still held out, and he was obliged eventually to raise the siege, and marched to Jeysulmeer. Afterwards he withdrew to the fortress of Umurkot in the desert, where the empress gave birth to the infant Akbar, A. H. 949. Humayoon subsequently returned to Bukur, and leaving his Wuzeers Moojirhid Khan and Moohibb Ali Khan with the army to besiege it, set out for

* *Tunab.* A Tunab according to the measurement then in use was derived from Arabia, and equal to fifteen yards. The following are the dimensions of the Arabian tunab and jureb.

6 Barley grains placed lengthwise one above the other,	1 finger.
32 fingers,	1 ziru,
60 Ziru,	1 tunab.
4 Tunab,	1 jureb.

Thus a jureb comprised an area of 3600 yards.

This measure is still used in Kabool, except that only twenty-four fingers go to the ziru.

† A Khurwar is equal to about 1050 lbs. avoirdupois.

Kandahar. They failed in obliging Muhmood Khan to capitulate, and he died during the siege, and was succeeded by an officer of the same name. After this the Wuzeers marched to Thutta. Moohmud or Moohummud Khan, acquired independent, sovereignty and historians distinguish him by the title of Sooltan. He died 980, while Meer Eesa of the Turkhanee tribe from Thutta was besieging the fort.* In the same year Sadood-deen, son of Meran, of the lineage of Moohummud Mukaee Kuguree, was chief of the Suyuds of Bukur, amounting to seventeen hundred families. They had suffered great inconvenience and privations during the siege, and determined with the consent of their superior to abandon the fort.† They accordingly settled on the east bank of the river on the Lohuree hills, a little to the south of Bukur, and founded the city called after the hills Lohree, improperly Roree.

The fortifications were rebuilt and restored the last time by the governor Nuwab Ghoolam Sudeeg Khan, about fifty or sixty years ago, in the reign of Timour Shah, to whom Bukur then belonged. To obtain bricks he broke down the tombs of Puthans which covered the heights of Sukhur, and reduced them to a complete ruin. The open space between the walls is of irregular breadth, being in some places thirty feet, in others less than twelve. The Alum Punah to the NW. is now about eight feet high, and more than double the height to the south, and looped for matchlocks, but without embrasures: It does not extend to the east and south-east faces, where the Indus almost washes the base of the wall, and leaves no path over the rocks. About half the Alum Punah on the faces not mentioned is fallen, and was in course of repair when our troops arrived in 1838. The rampart is twelve feet wide. The natives consider the fort impregnable, but a few rounds from heavy artillery would throw down any part. The lofty embattled pinnacles are imposing to the eye even in ruin, and the fort is admirably situated on the Indus between the towns of Roree and Sukhur, but the superior elevation of the hills on both banks make it of little value as a stronghold. The British have converted a hill near Sukhur into a battery for seven cannon, and a few hundred native infantry and a small detail of artillery formed the garrison of Bukur in the autumn of 1839. A few ceriss and peepul‡ trees take root in the walls, and hasten their ruin. A large bastion to the NE. has already fallen, and others

* The tomb of this enlightened prince still exists in good preservation among the Kalhora sepulchres at Thutta, and is remarkable for the beauty of its carvings.

† Captain Macmurdo states that the Arghoons were jealous of the great power possessed by the Suyuds, and compelled them to leave the town, and occupy Lohree. This was probably true, and the fact of their sending grain to Humayoon's army proves their bad feeling to the governor.

‡ Mimosa cerissa and Ficus indica.

totter. The fortifications are brick hardened in the sun, and faced with large square bricks and tiles laid in mud instead of cement. Part was formerly encrusted with porcelain glazed, coloured, and ornamented with Persian inscriptions.

The once flourishing city of Bukur contains now only twenty-five houses, and exhibits a deplorable picture of desolation. The British have converted the governor's palace on the east wall into a powder magazine, and the entire area is covered with mounds fifteen or twenty feet high of bricks, the debris of buildings and ordure that have accumulated for ages.*

The Indus sweeps round Bukur in a rocky channel, half a mile wide, in form of a horse-shoe, of which the fort occupies about the middle, and can be traced in clear weather through a perfectly level country for fifty or sixty miles. The stream directs its force at present against the west bank, a little above Sukhur, and were it to give way, there are no obstacles to oppose the course of the river over the flat plains. In event of this contingency, and the Indus deserting Bukur, it would be valueless as a military position; and it will probably happen at no distant period, unless checked by a strong embankment: the current turns now about eight miles from its natural direction.

In 1839 the Indus began to subside the last week of August, leaving extensive shoals opposite the fort, which arrested reeds and timber. It rose a little the three last days of the month, but six weeks afterwards shoals filled above a third of the bed, and decayed vegetable matter and slime, exposed to a burning sun, produced exhalations that generated remittent fevers. In the end of October the river had fallen about sixteen feet, and entirely deserted the NE. and SW. angles of Bukur, leaving a bank on the north face, a quarter of a mile in circuit, and a shallow ford alone divided the fort from the island of *Khwaju-ka-than.* The bank to the SW. was three feet above water level, and more than a furlong in circuit. The Indus appears to be forsaking its western channel, which had in the beginning of November only four and a half feet water in the deepest part, but the strong current could not be forded. The eastern channel has a width of nearly five hundred yards.†

* Quantities of gunpowder, amounting to a hundred pounds together, were found buried in three places, and are supposed to have been introduced by the Talpoorees to blow up our troops. In July 1839 a Sipahi while cooking was thrown violently on his back by an explosion, but escaped without injury, though his food was projected into the air. People had lighted fires on the spot for months, and that an explosion did not take place before is ascribed to the dampness of the earth, which is filled with saltpetre. Had the great Magazine ignited, it would have destroyed every soul in the fort, and rent the fortifications to atoms.

† Captain Thompson, the Principal Engineer of the Bengal Column of the Army of the Indus, threw a flying bridge over this channel, which was swept away shortly after

In July and August the river pours down floods of water over the rocks at short intervals with angry violence, and casts up waves a mile and a half below Bukur with a noise that can be heard a distance of several miles. It frequently dashes boats in pieces, and drowns people bathing. In 1839 it thrice carried away the *pont volant* connecting the fort with Sukhur, and sacrificed the lives of two men employed to replace it; and the ferry boat that left Sukhur every morning for Roree lost about a mile and a half in the transit, which it accomplishes in the cold months in about seven minutes.

Bukur is the only pretty spot on the Indus in its course through Sind. The growth of timber is less luxuriant than at Gouahatee, the principal town of Assam, but the broad and rapid stream with rocks frowning over it, and the picturesque groves and islands, remind the traveller forcibly of that beautiful and unhealthy spot. The view of the town of Roree from the rampart is a fine subject for the pencil of an artist, and embraces on the north a small island, which the Moslem and Hindoo have endowed with a sacred character. A shrine and tombs, terminating in numerous gay spires of coloured porcelain, cover another island below the fort, and a third lower down the stream forms the abode of a solitary anchorite, who has lived there many years on the donations of pilgrims. Fruitful date trees mixed with the mango, plantain, and pomegranate, line the shores of the stream for miles, and flocks of pelicans, remarkable for the whiteness of their plumes, are seen in the summer months sailing majestically on the current.

Note on the rivers Nara and Arrul in North Sind.

The Nara ranks first among the streams of North Sind that receive their waters from the Indus, and spreads fertility over a district inferior in wealth and importance to none in the Ameer's dominions. I ascended the stream in June 1839 in a vessel of seven hundred muns burthen, and as the country it runs through has only been visited by two or three European travellers, I have thrown together a few notes on the voyage, which occupied a fortnight.

Nara signifies a snake in the Sind dialect; and the river richly deserves the title, from the extraordinary sinuosity of its course, equalling, if it does not surpass, that of the Goomtee in Oude. From the point where it leaves the Indus, about thirty-five miles below Bukur, to its junction with lake Munchar, is about fifty miles in a direct line, but nearly one hundred and twenty by the course of the stream. The distance across a belt of land in

the army crossed in the middle of February. Another bridge over the western channel, connecting Sukhur with Bukur, stood till the end of March, when the floods destroyed it.

one of the turnings which the boatmen took an hour to circle was found to be only twelve paces From the sharpness of the turns it is often impossible to carry sail more than fifteen minutes together, and even when the wind is favourable for boats ascending the stream, they are dragged great part of the way by the track rope.

The Nara is navigated throughout its course four or five months of the year by vessels of eight hundred muns burthen. Boats proceeding northward always take this route in the inundations, to escape the current of the Indus, which it is impossible to breast without a strong favourable breeze. Those bound to Bukur re-enter the great stream about thirty-five miles below the fortress, and always return by it to the ocean.

The only part of the river where an obstacle occurred, was at the hamlet of Gahé, where the men, to save time, went up a channel which the farmers had lately opened by cutting an embankment to let off the floods which had risen suddenly, and threatened to destroy the crops. Here the stream, which has a westerly course above the village, turns abruptly south, sweeping round a sharp angle with immense force, and it was only after a dozen attempts that the men succeeded in dragging and pushing the boat up the rapids.

The stream rolls along a rapid volume of water from thirty to fifty yards wide, but sometimes diminishes to twenty, and has an average depth of about four. There are a good many ferries in the upper part of its course, traversed where the current is strong, by a *pont volant* worked by a man, who receives half a pye for conveying over a foot passenger, and double the amount for a horse or bullock.

The Nara is surrounded, where it leaves the Indus, with shoals and shifting sands, which make it difficult for boatmen to find the entrance. It is skirted in places by a wide expanse of fields unbroken by forest, and clusters of cottages at intervals of two or three furlongs. The grain cultivated is chiefly wheat, joowaree, and rice, and a good deal of cotton and a little tobacco. I saw ten or twelve Persian wheels working together, and in the gardens apple and nut trees, mangoes, grapes, and limes, luxuriant rose bushes, and a profusion of white and scarlet oleander. None of the fruits are remarkable for size or flavour. The soil is sand or stiff clay, and canals from six to ten feet wide, cut from the Nara, receive the floods and convey them through plains divided by low ridges and embankments: the crops are most luxuriant, but the mode of tillage slovenly, and the manure of a worthless description.

Fifteen miles from lake Munchar are extensive low lands bare of trees, and little elevated above the level of the Nara, so that banks are required to prevent the river overflowing. Part is cultivated with rice and wheat, and

part pastures sheep, herds of horned cattle, and a small breed of horses. Before the British arrived in Sind, grain was so plentiful that the people measured at a guess the quantity demanded by purchasers, and even now about forty seers of wheat are sold on the farms for a rupee.

The shores untouched by the plough are without paths, and the dense jungle of acacia and tamarisk of large growth that overhang the water is never cut, and is a serious impediment to boatmen in tracking. It would be a great benefit to commerce, if the peasants were obliged to remove the trees. Their villages are usually at a short distance, and they obtain wood for fuel, building, and agricultural implements from the jungle, and might without much additional trouble cut it on the river banks.

The country towards lake Munchar is lower and more intersected by streams than the tract to the northward, and extensive lakes and sheets of water covered with lotos and rushes harbour multitudes of geese and other water-fowl. Neither the domestic goose nor the duck is an habitant of this region, and though the river swarms with fish there is not sufficient demand for it to induce people to make fish-catching a profession. The common fowl is plentiful, and the people hardly know what price to ask for it. They are glad to exchange their poultry for earthen platters and pipes, and glass bottles of British manufacture, and our boatmen were seldom without a chicken for supper. There are no alligators in the Nara, but it is infested by a small leach, which is troublesome to those who bathe in it.

Shortly before the river joins lake Munchar, it flows through a channel which had lately been deepened, and the earth thrown up on the banks gave it the appearance of a canal, but the resemblance soon disappeared. The thick groves of tamarisk exclude the air, and make the atmosphere in summer oppressively close, and when the floods subside in September and October the soil engenders miasma. No dew fell during the time we were on the river, and our party slept in the air surrounded by swamp and jungle without suffering injury.

The people on the shores of the Nara are nearly all Moosulmans. Their hamlets consist usually of small groups of cottages at short intervals along the banks, and a sequestered spot in the vicinity, sheltered by trees, is set apart for the dead, and held sacred from intrusion. The huts are generally on rising ground, and built of mud with terraced roofs, on which the farmers raise a chamber of reeds, where they pass the night in summer to escape the suffocating heat and stings of musquitos and other vermin that swarm the river. When the peasant is too poor to incur this expence, he removes his mat, or bedstead, to the roof of his cottage, and in situations liable to inundation, resides in a shed covered and fenced

with tamarisk boughs. Sometimes he relinquishes part of this humble dwelling to his cattle.

The only town on this route besides Sehwan, is Khyrgaon, situated on the west bank of the Koodun, a branch of the Nara, and has not yet found a place in the maps; it is about thirty miles from lake Munchar, and has seven mosques and between 2,000 and 3,000 inhabitants, about a fifth of whom are Hindoos. The bazar was last year totally destroyed by fire, and the people were rebuilding it in a very superior style to that of the Sehwan and Thutta markets, which it promises to surpass in width and loftiness. The chief articles exposed for sale are striped and coloured cottons.

The lake Munchar bears E. 10 N. from the town of Sehwan, and about sixteen miles distant. In the season of inundation it spreads far beyond its limits, and overflows the groves of tamarisk and rushes on its shores. The figure is a long oval, between forty and fifty miles in circuit, and the greatest length is east and west. The shores are fringed with lotos, and rushes six feet high, except on the south-west side, where there is a waste of sand. Barren hills are seen at a distance rising in altitude as they recede from the lake, and form the modern boundary between Sind and Beloochistan. A hot dazzling vapour floats in summer over these desolate heights, which are as unpromising to the eye as the mountains on the coast of Yemen, and afford no shelter for travellers. The solitary village of Jungar, with the domed sepulchre of Peer Bubber, is to the south, and the only inhabited spot distinguishable; near it are extensive meadows where sheep and buffaloes pasture. Among the varieties of fish that inhabit the lake I recognized the Rohoo, the Silun, and the Saolee, which are speared with bamboos barbed with iron, a common mode of fishing where water is sufficiently clear to distinguish objects below the surface, which is never the case in the Indus.

Lake Munchar presents a beautiful sight in the season when the lotos is in blossom; the plants occupy a circle of more than twenty miles, covering the surface of the water with a thick carpet of leaves and flowers far beyond the range of vision. A channel fifty or sixty feet wide, winds with many sinuosities through the midst of the lotos beds, and a current sets to the eastward at about two miles an hour. The water is clear, but has rather an unpleasant taste of vegetable matter, and a pole, three fathoms long, was dropped into it frequently without touching the bottom. To reach the Nara in the western limit of the lake, boats force a passage through reeds and lotos, and no one unacquainted with the navigation could discover the mouth, it is so completely hidden from view by these plants.

The river Arrul may be considered almost a continuation of the Nara, and after emerging from the east side of lake Munchar has a course of

about twenty miles to the Indus. The banks are fringed thickly with tamarisks and acacias, and an undergrowth of camel-thorn and turf. There are a few hamlets on the banks, and a good deal of land under tillage. The river expands nearly a hundred yards at Sehwan, and the depth in the middle is never less than twelve feet. Below the town its course is circuitous. Sehwan stands on an eminence on the west bank of the river, about four miles from its mouth, and close to the Lukkee hills, part of the great chain of Hala, that forms the west boundary of Beloochistan. The hills approach the Indus a little below the mouth of the Arrul, and consist of lime, in which a great variety of petrified shells, wood, and coral, are embedded, well worth the attention of geologists. I had not leisure to visit them, but Major Smee of the 5th Bombay Infantry, an indefatigable collector of shells, found the following specimens during two days he passed at Lukkee :—

Several species of Trochi,
A species of Helix,
———— Bulimus,
———— Turritella,
———— Cypæa,
———— Conus,
———— Terebellum,
———— Oliva,
———— Voluta,
———— Cryptostoma (genus of Voluta,)
———— Ostrea,
———— Pecten,

and a large species of Nautilus, measuring eighteen inches across. I believe the cowrie and core are rarely found in a petrified state. There are likewise hot springs in the neighbourhood, impregnated with sulphur and alum, and the last is an article of export.

Ruined houses, mosques, and sepulchres cover an enormous space at Sehwan, and are a melancholy record of the prosperity of the town under the Summa Jams, the Urghoons, and the Moghuls, before the Kalhoras deprived it of its independence. The modern town is said to contain 2000 families, of which a fifth are Hindoos, and there are forty grain sellers' shops. The houses are mud, and rise to several floors, the uppermost being often built on arches, and surpass in style and accommodation those of Hydurabad and Thutta. The bazar is narrow and crooked, but of considerable length, and covered with mats to exclude the sun. Belooch caps, shoes, silk strings for drawers, and a few other silk articles for the lower orders, are fabricated and exposed for sale. There is scarcely any trade, and an

entire absence of bustle and activity. At the time of our visit there were forty boats at the town, including one of 300 muns in progress of construction. Twelve were small craft belonging chiefly to Sehwan, and the rest to towns on the Indus. More than half were without cargoes.

The shrine of Lal Shah Baz, a holy man of Khorasan, is the great object of attraction to Moosulmans and Hindoos, who flock hither from the Dukhun, Northern India, and the Punjab. The tomb is a quadrangular edifice covered with a dome and lanthorn; round it are small domes and blue enamelled spires and coloured porcelain tiles, and inscriptions in the Arabic letter decorate the walls. A gothic arch admits the visitor to a paved court with arcades, where a number of mendicants lodge, and solicit alms in a tone of command rather than entreaty. A door on the side opposite the entrance, closed by handsome shutters of hammered silver, leads to a lofty domed chamber with Arabic inscriptions, niches, and a canopy. It contains the tomb of the saint covered by rich cloths, and the balasters with silver plates, much corroded by time. The numbers of pigeons that have sanctuary in the building give it a musty, disagreeable smell. The sepulchre is reputed to be rich in money and endowments, and enjoys the revenues of the Sehwan gardens, and many villages in the district. The Ameers of Hydurabad make pilgrimages to the shrine, and went there in 1828 to return thanks to Allah for restoring health to the late Morad Ali, the principal Ameer.

The fort of Sehwan stands on a scarped rock, about a hundred feet above the Arrul, and divided from the town to the south by a deep channel, which is dry nine months of the year. The interior is completely ruined, but the corner towers and shell of two noble gateways are tolerably perfect.

The temperature of the air on the Nara, in June, was considerably higher than on the Indus, as shown in the following table :—

Average range of the Thermometer on the Nara from 4th to 18th June 1839.		Average of Thermometer on the Indus during six days of June 1839.
Sunrise, ...	85°	85°
12 A.M.	103°	96°
3 P.M.	106°	98°
6 P.M.	102°	96°
8 P.M.	96°	91°

The mercury on the Nara rose several days at 3 P.M. to 111° and 112°, and once to 113° of Fahrenheit.

Note on Khyrpoor in North Sind.

Land owners who hold Sunnuds (title deeds) of rent free tenures of the Emperors of Dilhee and their successors, pay no revenue to the state.

Suyuds pay one-fourth of the crop; and the *ung*, or expense entailed by Government in collecting the revenue, is remitted.

Some noble families of Moghuls, Puthans, and Sindee Zumeendars pay one-fourth like the Suyuds.

A second class of cultivators pay one-third, a third class two-fifths, and a fourth class one-half the crop. The cess varies in different districts, and is regulated by the prince or his lieutenaut.

Proprietors of gardens pay revenue in cash. I have stated in my account of Khyrpoor that government leaves ouly one-sixteenth of the produce to the owner. I find on reference to my notes that in some places it exacts sixty, and iu others seventy-five per cent. Indigo is taxed a fourth, and is not cultivated in the districts of Roree and Sukhur.

Buhawul Khan, the Nuwab of Daoodpotra, collects in kind, nominally a third and fourth of the crop, but fines and exactions leave the farmer only half the produce of land near towns and villages possessing facilities for irrigation. Land distant from inhabited spots, and watered from wells, is taxed a fourth and sometimes a fifth for a term of years, according to agreement with the Zumeendar, who clears the land and digs wells, to irrigate it. The people complain universally of the high assessment, and the prince obliges Zumeeudars to grind in their mills a certain quantity of grain produced on the royal farms without remuneration. His oppressive measures have depopulated a large extent of country, and numbers of the inhabitants have settled on the west bank of the Sutluj, where the assessmeut though nearly as heavy as in Daoodpotra, is levied fairly. The land on the west bank is of better quality, aud yields a large return, which enables the peasant to support his burthen, and he enjoys complete security of life and property uuder the police system introduced by the late Runjeet Singh. The inhabitauts have put aside their arms, and in the large district of Mooltan, bordering ou the Sutluj, I am informed that it is rare to find a sword or matchlock in a family.

The people of the Sikh states west of the Sutluj pay a fourth and fifth of the crop either in cash or kind, and the former is sometimes obliged to purchase the government share at a price greatly in excess of the market rate. There are also profit and loss settlemeuts adopted, apparently from the system in operation in the British provinces, which are unfavourable for the farmer.

The ruler of the Punjab takes half the produce of "Silab," or laud inundated by rivers, aud a fourth or fifth, and sometimes as little as a seventh, of land irrigated from wells, according to situation and fitness for agriculture. The ruyeeuts are on the whole better off thau in Daoodpotra and Mumdot, where they save nothing, and make a bare subsistence.

The cess in the Puthau Chiefship of Muudot in the Sikh states east of the Sutluj under British protection, amounts to a third and fourth of the crop, and in 1839 the people were in a state approaching starvation from the total failure of the periodical rains.

G. E. Westmacott, *Captain,*
37th Regiment Native Infautry.

Three new Species of Monkey; with Remarks on the genera Semnopithecus et Macacus. By B. H. Hodgson, Esq.

Whoever has occasion to refer to the family of the Simiadæ in works of Zoology, will, I think, be struck with the fugitive and doubtful manner in which several proximate forms are generically separated from each other; and this impression is peculiarly likely to arise, if the reference be made with a view to classifying the ordinary Indian species. Are the larger ones (Langoors) *Semnopitheci* or *Cercopitheci?* Are the smaller ones (Bander) *Macaci* ant alium quid? It is universally laid down that the *Semnopitheci* and *Cercopitheci* both have cheek pouches; yet is there not really any trace whatever of these pouches in their prototypes, the Langoors of India, not at least in those of Nepal: and whilst Cuvier's type of the former genus has andromorphous canines, Horsfield's has these teeth as formidably developed as in the true Carnivora; the difference in *this* case being consequent only on nonage or feminity, though insisted on by authors as essentially diagnostic of separate types or genera.

Again, what animal exhibits the typical characters of *Macacus?* If *Rhesus,* then are our Indian Banders not *Macaci,* as generally alleged, for they have neither the elongated snout, nor the very short tail of that species: nor are their canines longer than in the Langoors, to which they bear a strict likeness in the outline of the profile, and in the facial angle; the only differences in these respects being caused by the greater dip between the brows at the base of the nose, owing to the superior saliency of the orbital bones, and by the shortness of the round terminal nares.

Without further preface, I shall now proceed to give a summary description of our Nipalese species of Langoor and of Bander, prefixing to each an amended indication of the generic character, for the reasons above assigned.

SIMIADÆ.

Genus. Semnopithecus.

Generic character. Facial angle 45 to 50; face flat; nose short, with long narrow lateral nares; head *depressed;* limbs long; thumbs small, remote; callosities large; *no* cheek pouches; 5th tubercle on last molar

present or absent (a trivial idle mark); canines variable, large only in grown males, for the most part; stomach sacculated and banded as well as intestine; tail very long, commonly tufted, and usually exceeding the length of the animal. Very agile; grave deportment; gregarious; not docile.

Species new. Schistaceus hodie (Nipalensis of Catalogue). Habit of Maurus. Dark slaty above; below and the entire head, pale yellow; mere hands and feet somewhat darkened or concolorous with the body above; a pencil of black hairs radiating upwards from the brows; concolorous; tail longer than the body, and more or less tufted; skin black; nude on face, and on last phalanges of anterior digits; hair on the crown short and radiated, on the cheeks long, directed back, and hiding the ears; piles or fur of one sort, nor harsh, nor soft, more or less wavy, three to five and a half inches long on the body, closer and shorter on the tapered tail: thirty inches long: tail without the hair, thirty-six: hand six and a half; foot eight and a half. Females smaller, with shorter canines. Habitatt. Tarai forest and lower hills, rarely the Kachâr also.

Genus Macacus.

Pithex (Πιθηξ, antiq.) *nobis.*

Generic character. Facial angle 50. Muzzle not elongated; callosities large; buttocks often nude; structure compacter, but generally resembling that of *Semnopithecus*, only that the thumbs are larger; the orbits more salient; the head rounder; cheek pouches distinct and large; the canines similarly variable, being large and grooved in grown males only; the nares short, round, and terminal; the stomach simple, though the cœcum and rectum be sacculated; and, lastly, the tail shorter, though usually equal to half the length of the animals. Agile; lively; gregarious; familiar; intelligent; and very docile in confinement.

1st. *Species, new.* Oinops (οινωψ) nob. (Nipalensis* of Catalogue). Tail, without the hair, half the length of the entire animal; ears partially exposed; buttocks posteally nude, and like the face, carneous red; colour of fur a full brownish yellow-red or deep rusty, passing into slaty grey on the anterior quarters, and purpurescent slaty internally. Twenty-two inches long. Tail, without the hair, ten; hand four and a half; foot six; pile or fur of one sort, as in the last, and of like quality and set

* Topical names dropt, as seldom appropriate.

generally: two to three and a half inches long on body, shorter on the tapered, untufted tail, and not radiating on the crown of the head. Females smaller, with less canines. Habitatt. Tarai and lower hills.

2d. *Species, new.* Pelops (πηλος et ωψ) nob. Structure and aspect similar to the last. Colours more sordid or purpurescent, slaty partially merged in rusty; buttocks posteally (except the callosities) clad: face nude and dusky, flatter than in the last. Twenty inches long. Tail, less hair, nine and a half; hand four and a quarter; foot five and seven-eighths. Habitatt. Northern region of hills exclusively. Fur fuller and more wavy than in Oinops.

N. B.—In all the above three species, the digits are basally connected by membrane, which in the posterior extremities reaches forward beyond the first phalanges. In the first, the thumb scarcely reaches the base of the metacarpus : in the second and third species, it extends only half way down the first phalanx of the index. In the posterior extrimeties the same digit has a size and strength, especially in the Macaci, more analogous to those of the thumb in our hand. In *Semnopithecus* this digit extends a little beyond the base of the metacarpus. In the Macaci to the end of first phalanx of proximate digit.

NEPAL,
March, 1841.

HEAD OF MACACUS OINOPS.

General notice of the tribe of Kujjukzyes (Upper Sinde). By Capt. N. Hart, *2nd Regt. Grenadiers (Bombay Army.)*

The Kujjukzyes are the descendants of a Kakur chief named Kujjuk, who resided with nine other Kakur chiefs in the village of Mejhtur,* ten koss from Borjaba in Kakuristan. In consequence of a feud in which Kujjuk was overpowered, he fled with his family and dependants to Seewee,† in northern Kuchee (to which town he had been in the habit of emigrating during the winter) and settled there. At that time the Governor of the country was Jeeymed Khan, the son of Baroo, the founder of the Baroozyes. They granted one cubit's breadth of the waters of the river Naree‡ to Kujjuk, to enable him to raise grain for his people. One evening on bringing in their flocks from the jungle a he-goat was missing. The tracks being followed up the next morning, the animal was seen baited by a wolf, which had not been able to destroy it. They secured the goat, and carried it home in triumph. This occurrence was considered so propitious by Kujjuk and his followers, that they determined on building a town on the spot. Some years afterwards, when their numbers had much increased, they obtained the grant of a larger portion of the waters of the Naree from Mirza Khan,§ the son and successor of Jeeymed Khan, and to evince their gratitude were ever foremost in the service of the Baroozyes. In process of time this grant was increased to eight cubits. From Mirza Khan Baroozye to Mahmood Khan, the father of Habeeb Khan, the power of the family declined, while that of the Kujjuks increased; and on Mahmood Khan's attempting to enforce the payment of the tribute claimed by the Dooranee monarch, they slew him. His son Habeeb Khan being unable to controul them, and being obliged to abandon Seewee, from which city they had cut off the water for their own use, the Candahar Sirdars sent Hajee Khan Kakur, with an army to demand the arrears, due since the dismemberment of the Dooranee monarchy. At this period, the tribe had eight chiefs, descendants of the sons of Kujjuk. They agreed to bribe Hajee Khan to destroy their enemy Habeeb Khan Baroozye, who was then living in the village of Kooruk, four miles from Seewee. The Hajee accordingly seized him one day in durbar, and gave him over to the Kujjuks, by whom he was put to death. His brother Sadoola Khan fled with his three nephews, (Shukur

* In Tassin's map E. Long. 69° 20′. Lat. 30° 30′.

† By Tassin E. Long. 69° 45′ Lat. 29° 40′, formerly called "Koohung." The fort still remains, though the town has long since been in ruins.

‡ This river has a bund across it, and cuts measured by the cubit are made from it for the supply of the different villages.

§ Founder of Mirzapoor near Mittree, at present in ruins.

Khan, Misree Khan,* and (name unknown) to Candahar, but their complaints were not attended to for a long time. At length Sadoola Khan was ordered to return to Kuchee and collect the revenue as his forefathers had done. The Kujjuks persuaded him that the Hajee alone had been the cause of his brother's death, and for some years they gave him a small portion of the tribute, but having quarrelled with him for demanding the whole amount, they killed him. His nephews fled to Lehree, and sought the protection of the Doomkees, where they remained some years. But reduced to extreme poverty, they were necessitated to throw themselves on the mercy of their enemies for subsistence, and the Kujjuks saw with pride the descendants of the Bazoozyes, once the governors of Kuchee and their masters, now begging at their gates for relief. For a year or two they were permitted to reside in the town, but then sent to Kooruk, where they have since remained.

To such a degree of power had the Kujjuks risen, and so great was their influence, that in A. H. 1228-9 (A. D. 1813), when Ahmed Yar Khan (the son of Bairam Khan), Surfuraz Khan (son of Moostapha), and Mall Zeinub, Nusseer Khan's daughter, fled from the protection of Mahmood Khan, the reigning prince of Kelat, they took refuge in the town belonging to that tribe, and Meer Khan, the head chief, agreed to assist them in obtaining a settlement of their claims. Mahmood followed them with an army, and for four days was encamped in front of the place, but doubtful of taking it, he granted two shares of the revenue of Dadur to the Mall, two to Ahmed Yar Khan, agreed to treat Surfuraz Khan as his own son, and then withdrew. In Mehrab Khan's time also, they succoured some fugitives, and that prince appeared before their walls with a large force, but eventually retreated without coming to blows.

On the occasion of destroying the village of their neighbours, the Murukzanees, about thirty years ago, Meer Khan was slain by a matchlock ball. The surviving Murukzanees sought refuge in the village of Duhpall, where they now reside.

The names of the Kujjuk chiefs, the descendants of the sons of Kujjuk, are :—

1. Ismael Khan, son of Punjoo, Punjoozye. (The head chief Punjoo being the eldest son.)
2. Eesan Khan son of Alee Khan Baranzye.
3. Syud Khan ,, Door Khan Dowlutzye.
4. Kurim Khan ,, Taj Mahomed Kashee.
5. Hassun ,, Meer Khan Kashee

* Lately serving in the Beeloche levy.

6. Meeran son of Jan Mahomed Kuryazye.
7. Door Khan ,, Nusseer Kuryazye.
8. Keemool Khan ,, Tutebar Sagzye.

The tribe is said to have numbered from seven hundred to one thousand fighting men this year.

The waters of the Naree, though latterly almost entirely kept by the Kujjuks for their own use, was formerly divided as follows:—

To the city of Seewee eight shares and one "Ghanga,"* for the use of its gardens.

The village of	Kujjuk,	8	shares	
,,	Kooruk,	8	,,	
,,	Gooloo,	6	,,	
,,	Lohnee,	4	,,	
,,	Murukzanee,	3	,,	Taken by Kujjuks
,,	Sapee,	6	,,	
,,	Abdoola Khuer,	3	,,	
,,	Mahmood,	2	,,	
,,	Bukhera,	2	,,	

Extracts from Capt. Hart's letter transmitting the above.

"A few miles from our camp is a large mound of earth, evidently the remains of an ancient city. The people call it "Dumb-i-Dulora Shah," who they say was a Kaffer king, who once reigned in Sinde, but owing to his manifold crimes, particularly that of marrying his sister, showers of ashes were rained on his cities by the Almighty. May not this king be Dahir-ben-Chuch, sovereign of Sinde, when first invaded by the Mahomedans?

"Should any thing turn up I will not fail to send it. I am told of five other similar mounds, where caves are said to *have* been found, but veracity is not a Sindian virtue, so until I can send people to search, I must doubt it. There are so few persons who do know any thing of the country, that at times I almost despair of acquiring any information; what I do get is purchased, for no one will open their mouths without being paid for it. Books (where so few can read aught but the Koran) are not to be had; one Moolla in Dadur says he had one containing an account of the "Dumbs," but it was burnt when his house was destroyed last November. That you

* Ghanga, a water course *always* running—differing from that measured by the cubit, which was only allowed to each cultivator one day and night in his turn. It was called a "Puo," and again subdivided into "Hitts," or finger breadths.

may judge how ignorant they are, even of their own annals, I send a copy of an inscription cut on the side of a hill at the entrance of the Chota Bolan pass. There are some tombs not far from it, but the villages in the immediate vicinity being deserted, no one can tell me any thing about it. I have sent copies to Shikarpoor and other places, without success. I was at first told it was done by the Kaffirs, and led on a wild goose chase, thinking I had at length got something worth communicating, but the letters that are legible are so plainly Persian, that it is not worth troubling oneself further about it, except perhaps to fix a date, could it be read. Even at Bagh, the capital of the district, where I offered any sum for an account of the town even, no one would write it. The only way would be to employ persons for the purpose, send them to the principal places, and then glean from their accounts and the Chuch Nama. I will, if you wish, send you all I have picked up, but I fear it will not repay you the trouble of reading."

Note.—The translation of the inscription, which is modern Sindee, was given me by a native merchant in Calcutta, who understands the language tolerably well. It is nothing more than a receipt for one hundred rupees, with the names of witnesses to the payment, (!) and in another style of character a query, as to what had become of a certain *Oula Mirza*, with a reply, that nothing was known of him. Some cyphers (probably a date) are illegible to my translator. I have written to Captain Hart, urging him to pursue his researches in Sinde, and he has since obliged me with an interesting notice of the Brehoees.

Second Notice of some forged Coins of the Bactrians and Indo-Scythians.—By Lieut. Alexander Cunningham, *Engineers.*

When I first drew attention to the subject of counterfeit coins, my remarks were chiefly directed towards those which had been cast in moulds formed from genuine ancient coins: I had then seen none of any other kind; but I was aware of the existence of one piece which could not have been cast; namely, the gold piece of Amyntas in the possession of Lady Sale, "which is in all respects similar to the copper coin of the same king, except that the figures are reversed." Not having seen the coin, I was induced to say, that "the fact of the type having been reversed, showed an advance in the art of forgery;" for I did not suppose that a spurious coin which had deceived any one, could be so ludicrously barbarous in execution as that of the forgeries

in the accompanying plate: for all of which, as well as for several cast forgeries, I am indebted to the disinterested kindness of Dr. Chapman of the 16th Lancers, who sent me all the suspected specimens in his own cabinet, and impressions of other suspected coins which he had seen, accompanied also with several genuine coins, that I might have, by a personal examination and comparison of them, the very best possible means of drawing correct conclusions regarding the genuineness of the suspected coins.

The forgeries which I am now about to notice are of two distinct kinds, of which the most likely to deceive, consists of pieces formed in moulds from genuine ancient coins. These are generally reproductions in gold of ancient silver coins; though some few specimens are known of silver, formed from genuine copper coins, and even silver gilt pieces have been offered for sale. This kind of forgery is however not likely to do much injury to the cause of numismatic science; for the cast pieces only repeat the very types and legends of genuine coins. Now the very fact of a gold piece being of the same size, type, and make as a known true silver coin, should at once lead a collector to suspect its genuineness, and to examine carefully whether the gold piece has not been cast. Of the genuine gold Bactrian coinage only one specimen of Euthydemus is at present known; and this scarcity alone should make collectors cautious how they purchase a gold Bactrian piece, unless it should be of a round form, and of a type unknown either in the silver or copper money of the same prince.

From what I have said, it will be evident that our best safe-guard against cast forgeries, lies in the cupidity of the forgers, who reproduce the ancient silver coins in gold, that their profit upon each piece may be greater; and by this very change of metal we have an almost certain proof, furnished by the short-sighted forger himself, that the piece cannot be genuine. Were the forgers of cast coins however to confine themselves to the multiplication of *silver* casts of genuine silver coins, the only means of detection would be in the want of sharpness and distinctness both in the figures and in the letters, and more especially where they join the field or ground of the piece; and in an excess of sharpness about the edges, instead of the smooth rounded edge of a genuine coin; as well as in a kind of dull frosted appearance, which cast coins usually have.

I will now describe the three gold pieces that Dr. Chapman has brought to my notice, all of which have evidently been cast in moulds formed from genuine silver coins.

The first is of Menander, and is a cast of a well known type, having a bare diademed head to the right, and on the reverse Minerva Promachus: this was purchased at Kabul for 30 rupees; some ducats also which were bought from the same person by another gentleman, have since turned out to be forgeries.

The second is likewise of Menander, but of a different type; the bare diademed head of the king being to the left, and his right hand being raised in the act of hurling a javelin forward. This was also procured at Kabul.

The third is of Antimachus, being a gold cast of the commonest type of the silver drachmas of that prince; with a figure of Victory on one side, and on the reverse a horseman at speed. This piece was likewise purchased in Kabul, and I have no doubt that all three of them are the manufacture of the same hand.

The first of these pieces is in the possession of Major Fitzgerald, and the others belong to Dr. Chapman, who when they were presented to him by a friend, at once suspected them to be forgeries; and my examination of them only confirms his suspicion.

The gold piece of Menander belonging to Dr. Chapman, weighs 74 grains, whereas the gold piece of Antimachus weighs only 56 grains; the difference between them being 18 grains. From an examination of seven genuine drachmas of Menander, and of five of Antimachus, I find that the heaviest of them weighs 40 grains, and the lightest one 32 grains; the difference between them being only 8 grains, or less than one-half of the difference between the two gold pieces. But as gold is less liable to injury and corrosion than silver, the extreme difference of weight between ancient gold coins should not *be so great*, as that between ancient silver coins; yet here we find that the difference between these two gold pieces is more than double the greatest difference to be found between any two silver coins. Now as this excess of difference between the gold coins is too much to have arisen from the effects of time, we must look for some other cause; and that this cause can only be that the two gold pieces have been cast in moulds formed from genuine silver coins, is proved by the following facts.

1. The heaviest of the genuine silver coins weighs 40 grains; and as the relative specific gravity of silver to gold is about 11 to 20, we have; as 11 is to 20, so are 40 grains to $72\frac{8}{11}$ grains; the weight which a gold piece would be if cast in a mould formed from a silver coin weighing 40 grains, and within $1\frac{3}{11}$ grain of the actual weight of the cast gold piece of Menander.

2. The lightest of the genuine silver coins weighs 32 grains; and therefore as 11 : 20 : : 32 : $58\frac{2}{11}$ grains; which would be the weight of a gold piece if cast in a mould formed from one of the lightest genuine silver coins; and which is within $2\frac{2}{11}$ grains of the actual weight of the cast gold piece of Antimachus.

3. The difference between two pieces thus formed is $72\frac{8}{11}-58\frac{2}{11}=14\frac{6}{11}$, or nearly double the difference between the heaviest and lightest genuine silver coins; and also very nearly the actual difference between the two gold pieces under examination. The metal of the Antimachus is of a paler colour than that of the Menander; and therefore as it must contain more silver, its relative specific gravity must be less: if however the metal of the two pieces had been the same, the difference between their weights would have been a grain or two nearer the difference which I have calculated.

From these facts, then, I come to the conclusion that, as the weights of these two pieces are the same as the weights of gold casts made in moulds formed from the heaviest and lightest genuine silver coins; and as the difference in weight between the two pieces is more than double what it should be if they were genuine coins, and very nearly the same that it would be if they were cast as before said; these pieces of Menander and Antimachus must be forgeries taken from genuine silver coins: a conclusion which is fully borne out by all the suspicious circumstances observable in their appearance.

There is a faintness and an indistinctness in the outlines of the figures on these pieces, that stamps them at once as cast coins; and where the relief in the figures on the original coins is small, it is seldom reproduced in the casts; as in the instance of the gold piece of Antimachus, on which the horseman has no neck, and the horse has scarcely any visible pasterns; and where the letters are at all crowded on the original coin, the spaces between them become filled up in the cast piece, and render the legend almost illegible; as in the

gold forgery of Menander, where the letters ΑΝΔ are joined together by several flaws; and this place I suppose to have been the mouth of the mould, and that the letters have become confused together by the more rapid cooling of the molten metal towards the neck of the mould, which prevented it from entering perfectly into the hollows of the letters at that part. From the same cause the letters ΒΑΣΙΛ on the gold piece of Antimachus are totally obliterated. I may add also as a further proof of the spuriousness of these pieces, that, when I showed them in the midst of several genuine silver coins to a native goldsmith, and asked him if he could make me some casts from them, he replied, that the figures and letters of the casts would not be so clear and distinct as on the original coins; and then added, as he picked up one of the gold pieces, "This was made in a mould."

Of the second kind of forgeries, the specimens which have come to my notice, are chiefly of silver, with the exception of Lady Sale's gold piece of Amyntas, and the gold piece of Kadphises engraved at the foot of the accompanying plate.

No. 1. A round silver piece of the size of a tetradrachm, weighing 243 grains. It is evidently imitated from a coin similar to Dr. Swiney's tetradrachm, published by Mr. James Prinsep in the Jour. As. Soc. of Bengal, for November 1836; if not indeed from that very coin; which I had frequent opportunities of seeing, when it was in Dr. Swiney's possession. Its relief was exceedingly bold, as I have shown in the left hand section of the plate, and this boldness is what will always be wanting in forgeries made by natives of India, whether from modelled moulds, or by engraved dies. The section to the right is of the spurious piece of Euthydemus; and a single glance at the two sections will be sufficient to show the great difference in the relief of the head of the two coins.

It is true that there are ancient tetradrachms of Euthydemus of great rudeness of execution; (vide, Jour. As. Soc. of Bengal, June 1833; plate 11; Fig. 6,) but even they are distinguished by a boldness in the relief of the head, which is not to be found in any of the modern forgeries, which I am about to describe. These ancient rude tetradrachms are discovered chiefly in the neighbourhood of Bokhara, from whence many have passed into Russia, and have been published by the celebrated Russian antiquary M. Köhler. I have one now before

me which likewise came from Bokhara; it weighs only 140 grains, and is therefore properly only a heavy didrachma: it is in high relief, and of extremely barbarous make; but as coins of this description are found in great numbers about Bokhara, there can be no doubt of its genuineness. This specimen must therefore have belonged to a local coinage of Euthydemus, which was confined to Bokhara alone as a tributary state; for if Bokhara had been under the immediate government of Euthydemus, there would either have been a royal mint established, or none at all; but if Bokhara was, as I suppose, a state tributary to Euthydemus; then it is easy to believe that one of the stipulations of the tribute was, that the money of the Bokhara state should be coined with the head, and in the name of the paramount sovereign.

Another point which distinguishes the engraved tetradrachm as a spurious one is its utter barbarousness as a work of art; the sketch in the plate gives a faithful outline of the head, preserving all its peculiarities; of which the most remarkable is a full eye in a side view of the face. This singularity at once stamps this piece as a forgery, and proclaims it to be the work of a native of India, whose artists invariably represent a full eye, even in a side face.

A third peculiarity is the fringe observable around the eye, on the forehead, before the ear, beneath the chin, and on the shoulder; which almost tempts me to believe that the forger had copied his die from Mr. Jas. Prinsep's engraving; for these fringed parts in the spurious coin are the very portions that are shaded darkly in Mr. Prinsep's etching. This supposition is still further borne out by the want of the central portion of the upright stroke of the monogrammatic letter Φ on the reverse of the spurious piece; this part in Mr. Prinsep's etching being so much fainter than the other strokes of the letter, that it might easily have escaped the eye of a forger, who was ignorant of the Greek characters.

The last peculiarity which I need notice is, that the standing figure of Hercules on the reverse is without a club: for the forger ignorant of the figure represented on the true coin, has overlooked the fact that the lower part of the left arm is concealed beneath the lion's skin: he has accordingly transformed the club, which reposes in the hollow of the arm on the original coin, into that half of the arm which should be

hidden by the lion's skin, which it carries, and he has omitted the club altogether. This omission alone is sufficient to prove that the engraved tetradrachm is a forgery; but when taken in conjunction with the lowness of relief in the figures, the ludicrous barbarism of its workmanship, the full eye in a side face, the two feet of Hercules turned to one side after the fashion of Indian art, and with the incomplete monogrammatic letter Φ, there can be no doubt whatever that it is a forged coin.

I observe that both the legs of Hercules exhibit a double outline to the right, which can have happened only from double striking; proving clearly that this piece must have been struck from dies engraved by the forger. When dies are once engraved they may be used either for striking, or, with the addition of some clay round the edges to separate the two dies to a distance requisite for the thickness of the coin, they may be used as a mould for casting forged pieces; and indeed Dr. Chapman, to whom this piece belongs, mentions that there is a cast of it in existence. The piece was procured at Bajáwur; and it has been subjected to the fumes of sulphur to give it a dark appearance.

No. 2. A small round silver piece of the size of a drachma, weighing 61 grains; it is one of two pieces in the cabinet of Dr. Chapman; and there is a third specimen also weighing 61 grains in the possession of another gentleman, of which an impression is now lying before me.

The execution of this piece is considerably more barbarous than that of the spurious tetradrachm of Euthydemus just described. The head faces to the left, instead of to the right, as on all the genuine coins of Eucratides: one of the three spurious pieces however has the head to the right. The change in the direction of the head, from right to left, may possibly be owing to the inadvertence, and not to the cunning of the forger; for if he engraved his die from a genuine coin, and not from an impression, the die would have the head in the same direction as the coin, and the stamps made from it would be reversed. I doubt however whether the forger had a genuine silver coin in his possession; if he had one, he would surely have made several casts from it, instead of putting himself to the expence and trouble of cutting dies. I am therefore inclined to believe that the forger had nothing more than a sketch to guide him in engraving the dies of this

grotesque piece of Eucratides. The eye is scarcely visible, and the nose, mouth, and chin are worthy only of a ludicrous mask. The caps and palms of the Dioscuri are also strangely disfigured; and the name is corrupted to □ΧΛΑΔΤΙΛΛ on the first specimen, and on the third to ΒΑ≡ΙΛ≡ΩΣ □ΧΚΡΑΤΙϥ; all which suspicious circumstances prove most incontestably, that these pieces are forgeries.

No. 3. A square silver piece of large size, weighing 118 grains; procured by Dr. Chapman at Peshawur. The execution of this piece is very much superior to that of any of the others in the accompanying plate; but there are several suspicious appearances about it, which induce me to believe it to be a forgery. Of these the principal are; its square form; its identity in size and type with a copper coin already known, having an owl on the reverse; and the total omission of the Bactrian Pali letter Ƥ *s*, at the end of the word *Maharajasa*, although there is plenty of room for it on the piece. It is curious to observe that the same omission occurs on the genuine copper coin published by Mr. Prinsep, from the corner of the coin having been cut off (vide Jour. As. Soc. of Bengal; November 1836. Fig. 6,) and on this account alone I am inclined to suspect that this forged piece must have been stamped by a die copied either from that identical coin, or from a sketch or impression of it. I have no doubt whatever that the piece is a forgery.

No. 4, is likewise a square silver piece of large size, and is of extremely barbarous workmanship; the title of ΒΑΣΙΛ≡ΩΣ is spelt ΒΑΣΑΙ≡ΩΣ, and the name is written Μ≡ИΛΗ . . . ; some of my objections to the genuineness of the last coin, apply equally to this; namely, its square form, and its identity in size and type with a known copper coin, having Minerva's Gorgon-headed shield on the reverse. These facts alone are sufficient to raise suspicion; but when coupled with the barbarously rude execution of the piece, and with the jumbling of the letters of the legend, I have no hesitation in declaring it to be a most pitiful forgery.

No. 5, is another square silver piece of large size, and of the rudest possible workmanship. The king's head and the figure on the reverse are both in directions contrary to what they are upon the original coin; and this reversal of the figure of Minerva, betrays that the piece is a forgery; for it brings the buckler upon the *right* arm, and leaves the

left arm to wield the spear; thus making the goddess of Wisdom left-handed. The legend also is much corrupted, and reads ΒΛΣИΞΩΣ ΝΙΚΔοΤοΡοΣ ΛΠΥΝ . .; the missing letters of the name being the very same that are wanting upon the coin that was stolen from Colonel Stacy.

In the legend of the reverse, I observe that the initial letter of the name in the corrupted Bactrian Pali characters has a foot-stroke to the left, the same as in Mr. Jas. Prinsep's engraving; but this stroke does not appear on the plaster cast of that coin, which I have now before me; nor on a genuine round silver drachma of Amyntas, which through the kindness of Dr. Chapman I have been able to examine. On both of these, the initial letter of the name is the same as is found initial in all the names beginning with the letter A.

All the circumstances observable about this piece, stamp it at once as a forgery; its extreme rudeness of workmanship, its corrupted legends, and its having the buckler of Minerva placed in her right hand, all prove it to be a spurious piece; which its square form, and its identity in size and type with a known copper coin, only serve to confirm beyond the possibility of a doubt. It was procured at Peshawur from a man who had also a similar piece in gold; and the latter may very likely be the very piece which is now in the cabinet of Lady Sale. Here then, in addition to the spurious piece already made known by Mr. Raoul-Rochette, we have two more in gold and silver agreeing in all respects, save that of metal, with the copper coin of Amyntas, which was stolen from Colonel Stacy. The same sloping cut which is attributable to accident in the original coin, is here found repeated in all these spurious pieces; and I have therefore little doubt that they have all been copied from sketches or impressions of that very coin.

In No. 6, I have given the Bactrian Pali characters of the name of Menander, as I find them upon a beautiful square coin of that prince of middle size. The first letter is *m*, inflected with the vowel *e;* the second is *n*, with a dot to the left below, which invariably represents the long *a;* the third character is a compound, the curve at the top thus ⊂, being one-half of the Bactrian character ε *n;* the middle portion is *d;* and the foot stroke to the right is *r*, which occurs exactly in the same way in the name of Eucratides, and in the word *putrasa;* and the last letter is *s*. Thus the four characters read simply according to the

Greek, *Ménándrasa.* I may add however that this is the only coin on which I have seen the name written in this way.

In No. 7 I have copied the Bactrian Pali characters of the name of Amyntas, as they appear upon the beautiful drachma belonging to Dr. Chapman. The first letter is the initial *a;* the second is *m*, inflected with the vowel *i;* the third is compounded of the half of the letter *n* (as above) and *t;* and the last is *s;* the whole four letters reading together in perfect accordance with the Greek, *Amintasa.*

It is a curious fact that the engraved originals of all the five forged coins, now published, are to be found in the same plate in the Journal of the Asiatic Society of Bengal, (Pl. 46. Nov. 1836); and as I have shown that the foot stroke to the initial letter of the Bactrian Pali name of Amyntas, which is found in the engraving in that plate, does not exist on the actual coin, and that the wanting portion of the stroke of the monogrammatic letter Φ on the spurious tetradrachm of Euthydemus is the very portion that is faintly sketched in Mr. Prinsep's engraving; I am almost tempted to believe that the forger of these spurious coins is in possession of a copy of that plate; and that all these forged pieces have been imitated from the engravings contained in it. It is scarcely possible that a native of the East, resident in Afghanistan, should have one of these plates in his possession; and as all the information which I have received from Dr. Chapman and from others, tends to prove that a *white* man is the superintendent forger of many false coins, I have little doubt that he (the white gentleman) is in possession of a copy of that plate, and of others; and that he has pointed out to his native assistants the particular coins which he wished to be forged. Of the common coins, such as drachmas of Menander and Antimachus, the forger has made casts, because he was easily able to procure original specimens; but of the rarer coins, such as those of the types imitated in the forgeries which I have just described, the fabricator, unable to obtain original specimens from which to form his moulds for casting, has taken advantage of Mr. Prinsep's etchings, and has imitated them as well as he was able. Such at least is the conclusion that I have come to from the facts before me; and I have hopes that before long, I shall be able to expose the white gentleman, who superintends the forging of these coins, to the merited contempt of the public.

No. 8. A small round silver piece, weighing 33 grains, in the cabinet of Dr. Chapman ; a duplicate of this piece is in the possession of Captain Hay, who has kindly favoured me with an impression of it; and I am thus, by a careful comparison of Dr. Chapman's coin with the impression of Capt. Hay's piece, able to say that they have both been struck by the same dies; and also that Capt. Hay's coin must have been struck before Dr. Chapman's piece, for on the reverse of his coin there is no visible flaw, whereas on the reverse of Dr. Chapman's coin there is a great flaw passing across the male figure, and a lesser flaw across the female figure: proving that the reverse die must have become cracked from repeated hammering, and that there are most probably many more similar counterfeits in existence. The original of this piece will be found engraved as No. 7, of plate 28, vol. iv. Jour. As. Soc. of Bengal.

The chief objections to the genuineness of this piece are; 1st. its metal, none of the Indo-Scythian coins yet discovered being of silver; 2nd. its size and type, which are identical with those of a gold coin already known; 3rd. the jumbling of the letters on the obverse, where I observe that the letter A is the only legible character of the words PAO NANO PAO; 4th. the want of a halo round the head of NANA, which is never omitted upon the genuine coins in gold and copper; and to these I may add, the filling in of the arms and body of the half length figure on the obverse with small strokes, apparently copied from the shaded lines in Mr. Prinsep's engraving.

The Indo-Scythic coins of Kadphises, Oerki, and Kanerki are always of superior execution; the relief of the figures is bold and rounded; and not low and flat as on this silver piece; besides which, the limbs and bodies of the figures on the genuine coins are never formed of outline strokes, as on this silver piece, but are boldly and creditably engraved. I have no doubt, from all these circumstances, that this silver piece is a forgery.

No. 9. A round gold piece in the possession of Mr. Conolly, C. S. It is of very inferior execution, and is evidently copied from the coin published by Mr. Jas. Prinsep as No. 1 of the same plate in which the original of the spurious piece just described is given. Dr. Chapman, who suspected this coin to be spurious, kindly procured me an impression of it, from which I have made the accompanying sketch. A cast

of the original genuine coin is now before me, and I can therefore vouch for the correctness of Mr. Prinsep's engraving.

On the obverse of this rude piece it is observable that the little charioteer of the original is replaced by two unmeaning strokes; and that the principal figure, as well as the body of the chariot, is ornamented with a row of small lines, which I believe to have been copied from the shading of Mr. Prinsep's engraving. The Greek legend is besides faulty: there being but a mere stroke for the Α of *Basileus*, and the final ϲ of Kadphises being altogether omitted; and these two letters are the only faulty ones in Mr. Prinsep's engraving. On the reverse the standing figure with a trident exhibits a double outline from double striking; and the body has three sloping lines drawn across it, which are the very number of shaded strokes in Mr. Prinsep's sketch. The Bactrian legend is particularly faulty; as I suppose from the incompleteness of the original engraving, from which the dies of this piece appear to have been copied.

We have ᒣ∪, *Maha* distinct enough, but then follows ⊓ *s*, for which the two upright strokes of the *r* and *j*, which are alone visible in the etching, might easily be mistaken.

From all these coincidences between this spurious gold piece and the engraving published by Mr. Prinsep, and from its extremely barbarous workmanship, I have no doubt whatever that it is a forgery; and I suspect that it must have been copied from Mr. Prinsep's engraving. It is certainly very curious that the same fact, which I have observed regarding the engraved originals of the Bactrian forgeries being found all in the same plate, is to be noticed of the engraved originals of these two Indo-Scythian forgeries, which are likewise found together in another plate of Mr. Prinsep's Journal. I shall therefore not only be not surprised, but I shall expect to see other forgeries of the rarer original coins engraved in those two plates; for I cannot help suspecting that the person who has forged all these coins is in possession of copies of those two plates.

From the long remarks which I have made upon the coins of this second class of forgeries, it will be evident that the best test for distinguishing a genuine coin is its excellence as a work of art; and this test will hold good with the earlier coins of the Indo-Scythians, as well as with the whole series of the Bactrian coins, which have pure

Greek names. The forged specimens which I have described are, with the exception of the Owl Menander, of such grotesquely barbarous workmanship, that a single glance is sufficient to detect their spuriousness. A collector therefore in examining a coin of this class has only to pay particular attention to two points; namely, whether its workmanship be worthy of Grecian art; and whether the double legends are perfect; in carefully attending to which he will escape the purchase

——Of many medals, "which if neither rare
Nor ancient, will be so, preserved with care."

Since writing the above notice, several other glaring forgeries have become known to me through the kindness of zealous friends. From Captain Hay I have received sketches of two square silver pieces of Menander, the exact counterparts of Nos. 3 and 4 of the accompanying plate. In the Bactrian Pali legend of No. 3, I observe the same remarkable omission of the final 𐨯 *sa*, of *Maharajasa*, although there is abundance of room for it on the forged piece. Captain Hay suspected them to be forgeries when he first saw them; but as they formed part of a large collection which was offered for sale, he was constrained to purchase the whole.

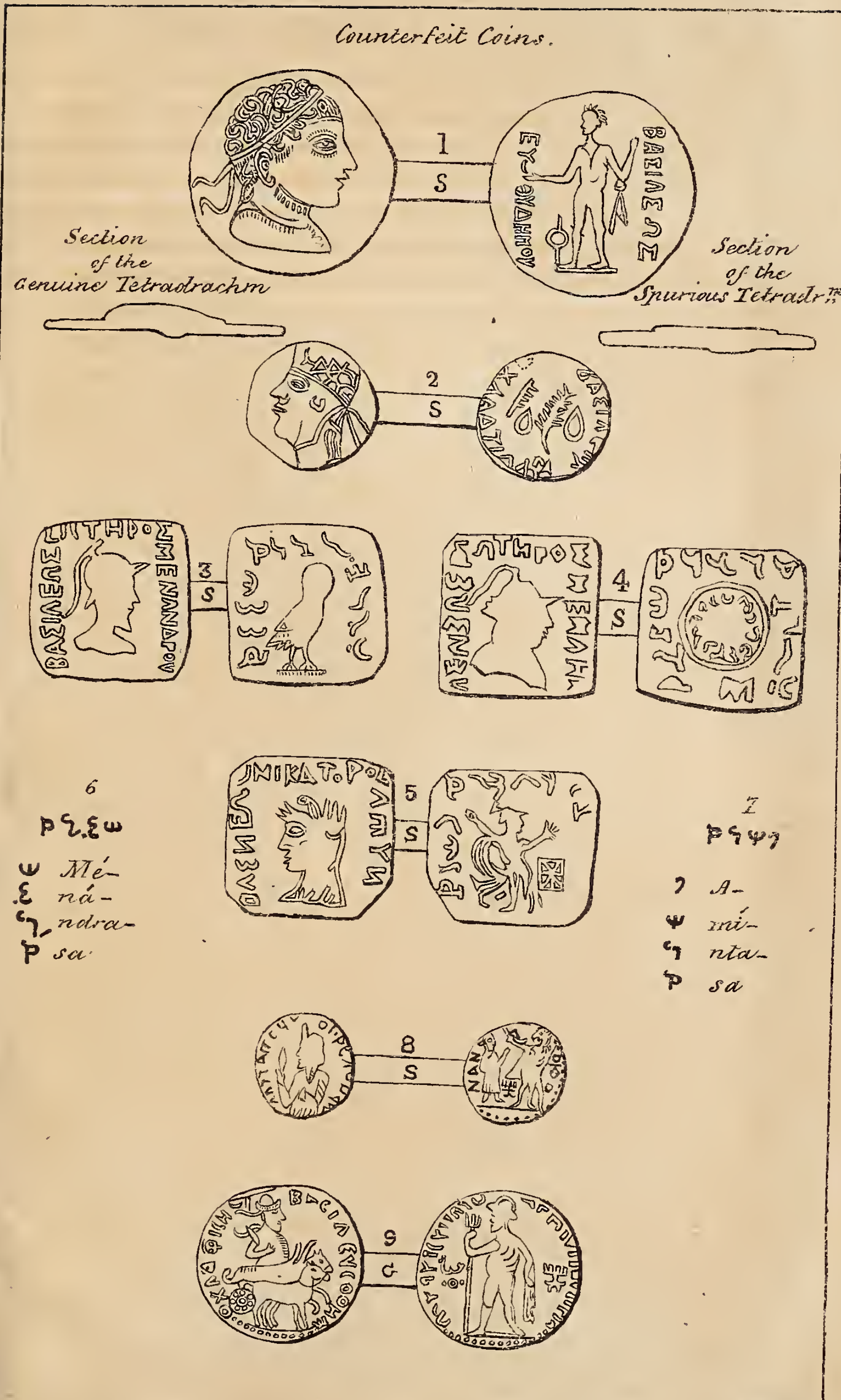
From Lady Sale I have received impressions of her gold Amyntas, which is of square form, and is in all respects, save that of metal, identical with the barbarous silver piece engraved as No. 5: it is therefore, as I supposed in my former notice, an undoubted forgery. Lady Sale also purchased two other gold pieces at the same time from the same dealer; one of them a Kadphises in his chariot, similar to No. 9 of the accompanying plate, and the other a Kadphises with a common bull, reverse, both of which I cannot help suspecting to be worthless, from the bad company in which they were found.

I have likewise received no less than nineteen forged silver pieces from my brother Lieut. J. D. Cunningham, at Peshawur, who knowing them to be forgeries, kindly purchased them for me with the hope that their early publication might put collectors upon their guard. Of these nineteen pieces, three are forgeries of a Roman drachma, and the remaining sixteen are forgeries of the drachmas of Menander; six being of the helmeted type, and ten of the bare-headed type, of which

five have the face looking to the right, and five have it to the left : the reverse of all of them being Minerva Promachus. It is needless to describe them more particularly, as they are equally barbarous in execution with those which have already been noticed ; but there is one peculiarity observable about them, which alone is sufficient to stamp them as bungling forgeries ; namely, that the legends on all the pieces of Menander are reversed both in Greek and in Bactrian Pali, the former reading from right to left, and the latter from left to right. The average weight of these pieces agrees with that of the genuine coins, being $36\frac{1}{4}$ grains.

Alexander Cunningham.

Plate



Cunningham. del

H. Archer lith.

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